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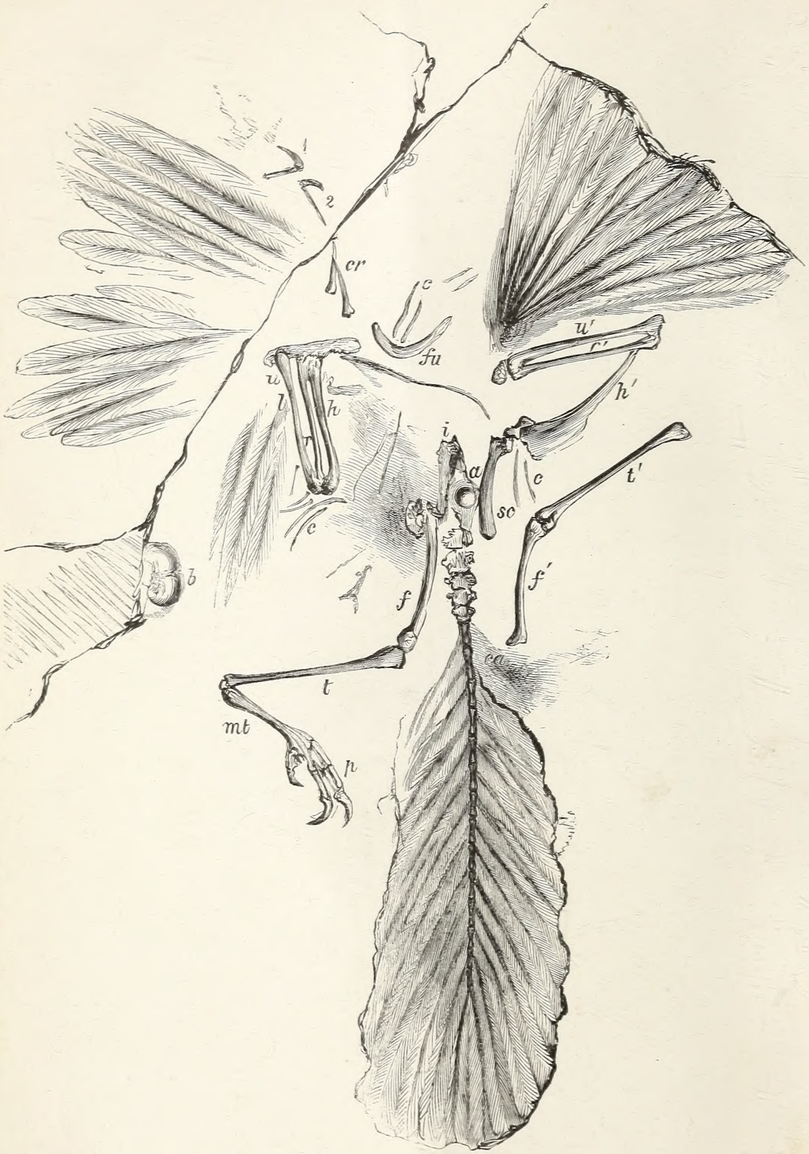
PLATE I.



ARCHÆOPTERYX MACRURUS (Owen).

In the National Collection, British Museum.

S. J. Mackie del.

[vol. 6.]

THE GEOLOGIST;

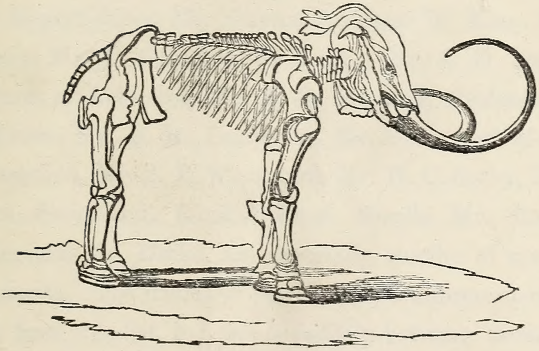
A POPULAR ILLUSTRATED

MONTHLY MAGAZINE

OF

GEOLOGY.

EDITED BY S. J. MACKIE, F.G.S., F.S.A.



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PREFACE.

Again the pleasant task recurs of thanking my friends for their encouragement and assistance; my only regret being, that the number of contributors to thank is less than heretofore. Those who have lightened by their contributions the labour which otherwise would have devolved on myself, have, during the past year, done me real service.

The papers and letters by my friends Mr. Du Noyer, the Rev. Hugh Mitchell, the Rev. Gilbert M. Smith, Mr. Meyer, of Guildford, Mr. Blake, Mr. James Powrie, Mr. Davies, the Rev. W. S. Symonds, Professor Rupert Jones, Mr. Simons, Professor W. King, Mr. Lechmere Guppy, Mr. T. Grindley, Dr. Leslie, Mr. J. D. Sainter, Mr. James Plant, of Leicester, Mr. S. R. Pattison, Professor Ansted, Rev. O. Fisher, Mr. E. R. Lankester, Mr. Binney, of Manchester, Count Marschall, Mr. S. P. Woodward, Mr. H. C. Sorby, Dr. Blackmore, Mrs. Strickland, Lieut.-Colonel Nicolls, Mr. Harrison, of Melbourne, and Mr. Drake, are especially worthy of my best acknowledgments. The names of some respected former contributors are absent from this list, but the friendship between them and myself continuing unbroken, welcome communications from them will most likely grace our future volumes. For my own part, the pressure of many important labours prevents such entire devotion to geology as I should like to give; but as far as my power permits, my best efforts will always be freely devoted to the interest of the readers and subscribers to this Magazine, from whom, so far as they are personally known to me, I continue to receive encouragement and support.

I would add here an earnest appeal to country collectors and provincial investigators to send notes of their doings and of the occurrences in their respective districts: not necessarily for publication, but to put me in possession of the means of securing a most valuable amount of information for the advance of science, which now is never brought before the world, and which passes resultlessly away into oblivion. When recently at Tynemouth, I observed extensive sinkings into an unusually interesting mass of boulder-drift, in the construction of a new powder magazine for the fort on the cliff within the fine old priory walls. The sections presented were in both north-and-south and east-and-west directions, the drifted materials consisting variously of sand, clay, and gravel, all containing flints and boulders of limestone, and other rocks; some, scratched and scored. The gravels commingled with runs of sand and intercalations of clay, presenting, notwithstanding their intricacy of commingling, evidences of the direction of drifting, not shown in the boulder-clay exposed along the Durham coast. My stay there was extremely limited, yet, although much engaged upon other matters, I found time to make some very rough sketches in my note-book, and to bring away my pockets full of small specimens of as many different boulders as I could. Still, what I did was not sufficient to enable me to give such an account of this remarkable cutting as it deserves; and as no trace of its existence is, as far as I am aware, shown on the face of the cliff (except, it may be, obscurely on the river side, as far as I could judge from a casual look while walking along the new jetty), there is, perhaps, little chance of such an opportunity for its examination occurring again. If, however, I had been acquainted with any geologist resident in the place, or had any one there communicated intelligence to me, I should have had the opportunity of directing operations, although at a distance, and without visiting the spot,—just as, through Mr. Elliot's kind and early information, I was enabled to suggest the best manner of examining the Heathery Burn Cave, and of collecting any relics that might be met with in it. Of the mammoth bones at Leicester Mr. Drake kindly gave me immediate information. Of many other similar discoveries and occurrences I have also had early notice; but my great desire is to get still more,—indeed, as much as possible,—of such knowledge. Every one who knows me will know that if the senders wish the information given not to be used, they have only to tell me so, and their desires will be properly respected. The value of reporting events to some special geologist, is very great, and there can be no better course than to supply such intelligence to the Editor of this Magazine, which is intended especially to record the events of the passing time. I am also pleased to have these pages made use of, as has been done by Dr. Falconer in the concluding number of this volume, as a medium of making known requirements of particular material for valuable labours in progress.

I am also gratified at the free criticism of my own articles, especially when the criticisms are as valuable as those of Mr. Scrope on my earthquake paper. In the speculations I have made, and in those I shall hereafter make, I am not actuated by any desire of innovation, but wish rather to develop discussions of many points accepted as theories, often only because they are familiar doctrines, and as often on too slight grounds.

In concluding this Preface to my sixth volume, I have only again to express my continued good wishes to my many friends.

S. J. MACKIE.

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THE GEOLOGIST.

JANUARY 1863.

THE AERONAUTS OF THE SOLENHOFEN AGE.

At least seven geological ages ago, and there were aeronauts in those days. Not Glaishers and Coxwells, clinging to bubbles of gas at six miles high, but reptiles and birds,—the latter at least, and perhaps the former, capable of long and lofty flights. On the red sands of Connecticut, perhaps some two or three ages before, wingless birds had left their footprints; but nor bone nor feather has the searching eye of man yet looked upon to glean a notion of what those birds were like. Not from all the thick mass of stratified rocks deposited by lake or ocean in the long interval between the period of those im-

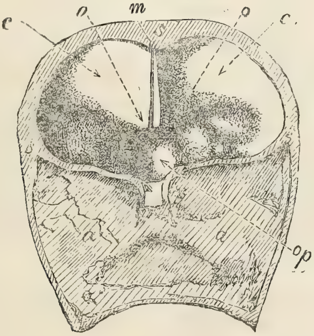


Fig. 1.—Front view of cast of brain of Carrion Crow.
cc, cerebral hemispheres ; *m*, median line ; *oo*, olfactory lobes ; *op*, optic lobe ; *ss*, section of skull ; *aa*, air-cavities.

pressed tracks—persistent through 2000 feet of stone—to the time when a solitary bone was entombed in the sandy mud of the Cretaceous Sea.*

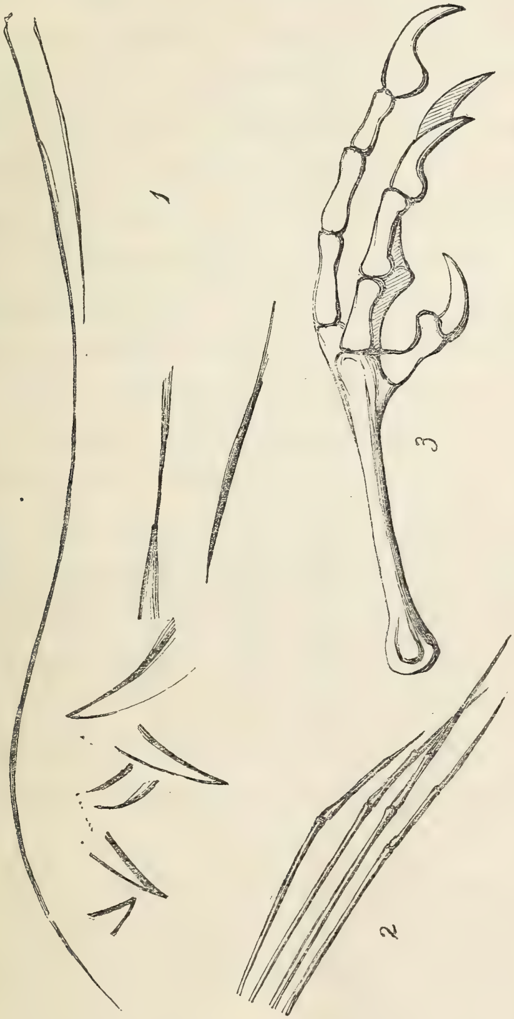
A little time ago the geological and palæontological worlds were astonished by the announcement of a feathered reptile. We recorded the reports without comment; the reason was, we could not rightly reconcile the statements to our conscientious content. We endeavoured to procure drawings, but without success; the specimen was for sale, and no doubt its value would have been prejudiced by its portraits being handed about as "*cartes de visite*" in the houses of the learned. The accounts that reached us were second-hand and by hearsay. Professor Wagner, on his death-bed, wrote the notice in the 'Sitzungberichte' of Munich, from the description of a M. Witte, who had derived his information from a sight of the specimen in M. Häberlein's possession. No doubt the mysterious announcements of a feathered reptile have enhanced the value of the Pappenheim specimen to its maximum extent, and have caused it to fetch a price which it never would have fetched had it made its *début* naturally as a bird; but its appearance in the sensation character of a feathered reptile made it a mysterious attraction, and caused it to have, in theatrical phrase, "a great run."

This singular fossil—a long-tailed bird—is now before us. At page 32 we give a report of the paper read by Professor Owen, before the Royal Society, on November 20, in which a minute description will be found. Since that time the specimen has been placed in the Gallery of the British Museum, where geologists who feel an interest in this remarkable discovery—and many unscientific persons, too, attracted to it by the notoriety it has attained—have flocked to inspect the blocks of lithographic limestone which contain the singular remains of the *Archæopteryx macrurus*.

Professor Owen and Mr. Waterhouse were both satisfied of its true ornithic nature long before the specimen was purchased for the National Collection, and we by no means regret the exceptional expenditure of so large a sum as has been given for it. It is indeed a most remarkable object, and as such, it was most praiseworthy of those officers to recommend its purchase, and of the trustees to venture the risk of blame from parsimonious economists, by acquiring it for that Collection which ought and does take pre-eminence amongst those of all nations, although it is packed so close as not to be a tithe as interesting or as instructive as it could and should be.

---

* Found, with turtle and pterodactyle bones, amongst the phosphate nodules of the Upper Greensand at Cambridge. It is reported that there has been discovered in the so-called "Permian," but really "Rhætic" rocks of South Carolina, in which Dr. Emmons had discovered the small insectivorous mammal Dromatherium, the *os sacrum* of a bird.



Figs. 1, Beak-like jaws, and 2, foot of same specimen of Rhamphorhynchus; 3, foot of Archæopteryx:—all natural size.

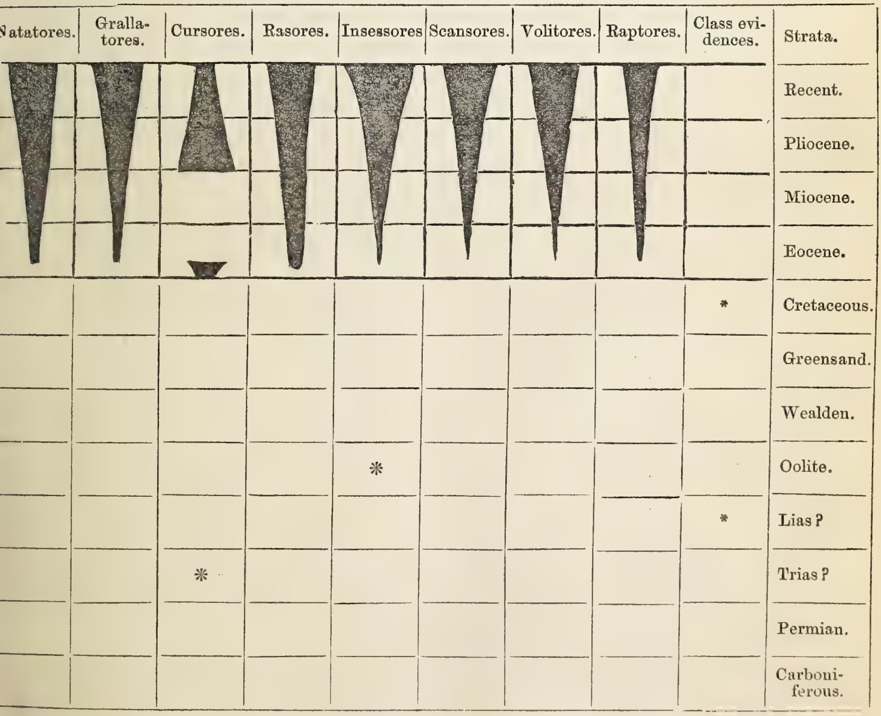
Even since the specimen has arrived and been inspected, an article in our contemporary 'The Intellectual Observer,' written with much care and a complete acquaintance with the bibliography of the subject, by Mr. Henry Woodward, of the British Museum, would seem to leave an open doubt that the Archæopteryx might have reptilian affinities, and that Rhamphorhynchus—the most bird-like of the Pterodactyles—might have had feathers, to preen which might have been one of the offices of a horny beak projecting beyond the few isolated teeth set near the fork of the jaws. Neither of these surmises are tenable. The Rhamphorhynchus had long strong teeth—unless we are mistaken in our interpretation of the excellent example acquired with other remarkable fossils besides the Archæopteryx in the Häberlein collection—down to the very end of the albatross-like bill or jaws (fig. 1, p. 3); while no traces of feathers have ever been met with associated with any of the numerous débris of those reptiles. As to the Archæopteryx, we are not aware that the inference originally arrived at by Professor Owen and Mr. Waterhouse, that it was a true bird, has been successfully impugned in any way. Those palæontologists who were silently present at the Royal Society's meeting, or who were "conspicuous by their absence," whose opinions we should have been glad to know, have maintained a significant silence. And the practice of naturalists in this respect seems nowadays like the practice of superior officers in Government establishments,—to find fault whenever they can, but never to give any praise.

It is most instructive to find in this fossil that more generalized type of structure presented by extinct birds of the Mesozoic age. The birds whose remains have been found in the Triassic, or as modern American geologists suggest, Liassic or Oolitic, sandstones of Connecticut, belong to the Cursorial type. These birds have been placed "at the lowest step of the scale of ornithic organization." In the abrogation or non-development of the wings, and in the number and direction of the toes, whose impressions have been afforded to us, we have evidence of a less amount of ornithic specialization in them, and a larger retention of the original vertebrate characters. In the Archæopteryx, the oldest bird of which osseous remains have as yet been found, we have also the retention of the more generalized type, but in another direction. The wings are indeed functional and capable of flight; the shape of the pectoral ridge on the humerus, and of the furculum, prove this; and the hinder extremities are modified for perching.

But in the twenty caudal vertebræ, we see the persistence of the law of generalization. In all embryo birds the caudal vertebræ are distinct: as life progresses, anchylosis goes on and they become shortened and united together. The eighteen vertebræ in the young ostrich are thus reduced to nine in the adult. In the retention of the separate vertebræ of the tail, the Archæopteryx presents an example of the persistence of embryonic or more generalized characters, and affords a demonstration of the great truth, often obscured of late years, that there exists a certain representation of the career of any single animal in the various stages through which the life system of the world has passed.

If there be any who yet entertain a doubt of the ornithic character of the specimen, and are misled by the occurrence of Archæopteryx in the Solenhofen slate, the very metropolis of Pterodactyles, to suspect any reptilian affinities for it, we hope that they will compare the hind foot of the Archæopteryx with that of any bird, and with that of the longtailed Pterodactyle (Ramphorhynchus) from the same Solenhofen beds, in the British Museum. In the birds we see the foot compact, stout, with an opposable hinder unguiculate digit, capable of prehension or of active support. In the reptile the homo-

Distribution of Birds.



logous organ is slender, without any opposable digits, and so weak that it could only have afforded a very feeble support (figs. 2 and 3, p. 3). We do see nothing in the Ramphorhynchus approaching to the powerful claws of the Pappenheim long-tailed bird.

The foregoing diagram (p. 5) will afford an idea of the distribution of the various orders of birds in Mesozoic strata.

The following table shows the distribution of some of the more striking types of Pterosauria throughout the upper Mesozoic beds.

DISTRIBUTION OF PTERODACTYLES.

	Lower Lias.	Upper Lias.	Stonesfield Slate.	Bath Oolite.	Forest Marble.	Oxford Clay and Solenhofen Beds	Coral Rag.	Kimmeridge Clay.	Purbeck Beds.	Hastings Sands.	Weald Clay.	Lower Greensand.	Upper Greensand.	Lower Chalk.	Middle Chalk.	Upper Chalk.
Dimorphodon macronyx	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
D. Banthensis	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Pterodactylus Bucklandii	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...
P. longirostris	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
P. crassirostris	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
P. Kochii	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
P. medius	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
P. grandis	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
P. brevirostris	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
P. Meyerii	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
P. sp.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
P. Fittonii	...	...	...	...	...	...	...	...	..	...	...	...	×	...	...	...
P. Sedgwickii	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
P. simus	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
P. Cuvierii	...	...	...	...	...	...	...	...	...	...	...	...	...	...	×	...
P. compressirostris	...	...	...	...	...	...	...	...	...	...	...	...	...	...	×	...
Ramphorhynchus longicaudus	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
R. Gemmingii	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
R. Münsterii	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...

Fossil birds' feathers have not alone been obtained from the Solenhofen slate. In the Miocene rocks of Bonn, as well as in Braunkohl, near Aix, examples have been discovered.

We are sorry there is a crack in the Archæopteryx stone, and an absent piece just where we would rather not have missed it: that is, just where we suspect the head might have been. The cranium, it is true, may be still in one or other of the slabs, or it never may have been in either at all. If the bird is the rejected or lost prey of some stronger creature, the head may have been torn off, and with the attached neck, may have been left on the dry ground elsewhere, or deposited in some other place miles away. But the presence or known existence of the head would have prevented any reptilian mystery; and the current statement that the head of the Guadaloupe human skeleton in the British Museum is in a museum in South Carolina, causes one to feel a silent hope that by no similar secretive principle may we be astonished hereafter by the discovery of the head of Archæopteryx in some Continental museum. In the block there is a semicircular portion, apparently of bone, which we have suspected might be a part of the skull; but we certainly should experience something like a sensation of relief, if we were to learn that through the aid of the Museum lapidary, the head was yet existent in the matrix. However, for what we have got we ought to be thankful; and especially are our praises due to the learned Superintendent of the Natural History Department, for his able, lucid, perspicuous, and convincing interpretation of these extraordinary remains.

Since the above was written, Mr. Henry Woodward has kindly handed us the cast (fig. 1, p. 1) of the interior of the skull of a carrion crow, which has been prepared by Mr. John Evans, F.S.A., who was struck with the resemblance, as he fancied, between the brain of a bird and the little limestone concretion within the bone-mark to which we have referred.

This suggestion was so probable, that we at once instituted a close comparison, and with the assistance of Mr. Carter Blake, we believe we have decisively made out the actual parts of the brain indicated by that seemingly unimportant protuberance, and for the apt means of the determination of which too much praise cannot be given to Mr. Evans. The story then, as we read it, is that a portion of the skull, and what may be termed the fossil brain, still remain in the slab. We will now attempt to describe this protuberance in the limestone as a fossil brain. The anterior part of the brain is presented vertically to the spectator, or stands out perpendicularly from the face of the stone. At its apex the site of the olfactory lobes are very evident, as is also, running down towards them, the median line.

The inturned edge of the cerebral hemispheres is also easily made out, and some trace of the optic lobe beneath the brain may perhaps be detected. Round the back of the counterpart cavity, in the opposing slab of stone, a portion of the transverse section of the back of the skull, showing the bony intercerebral ridge, is to be met with.

There is near this space a conchoidal fracture, which Mr. Blake thinks might be the impression of the parietal and frontal bones; but although we believe these bones were within the region of this space, we think the conchoidal fracture has been produced by artificial means. The proximity of these cerebral and cranial relics to one of the missing pieces of stone, renders it highly desirable that some pains should be taken to obtain it, as the beak of the bird's head would have probably projected upwards and inwards into it, as it covered the brain in the slab containing the chief remains. That is to say, the Archæopteryx's head would have rested on its back on the mud, with possibly one or two of the cervical vertebræ attached to it, the beak thus projecting directly upwards, exactly as we usually find those of dead gulls and other birds on our present shores.

This evidence goes far to support the admirable inferences of Professor Owen, as the fossil brain presents true bird's characters, and can thus be perfectly distinguished from the very peculiar form of brain in reptiles.

Explanation of Plate I.

c, costæ; *sc*, scapula; *h*, humerus; *u*, ulna; *r*, radius; *cr*, carpals; *i*, ilium; *f*, femur; *t*, tibia; *mt*, metatarsus; *p*, phalanges; *ca*, cauda (tail); *b*, fossil brain; *a*, acetabulum; 1 and 2, carpal hooks.

ON DIDYMODON,[*] A NEW GENUS OF MINUTE ARTIODACTYLE MAMMALIA, FROM THE EOCENE OF VAUCLUSE.

By Charles Carter Blake, Esq.,

Lecturer on Zoology at the London Institution.

Since the original foundation of the genus Dichobune by Cuvier,[†] and the critical observations made thereon by Owen,[‡] the national collection has continued to receive new accessions, indicating the existence of a certain range of variation in the molars of that genus.

The specimen (No. 30673) in the British Museum collection, is figured in Plate II., by Mr. Mackie. It consists of the three molars of the right side of a species of small quadruped closely resembling Dichobune. The length of the fractured ramus containing these teeth, of which the inner aspect is exposed to the observer, mea-

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[*] From δίδυμος, *twofold*, and ὀδοῦς, *tooth*.

[†] 'Ossemens Fossiles,' vol. v., *passim*.

[‡] Quarterly Journal of the Geological Society, vol. xiii. 1857, p. 254.

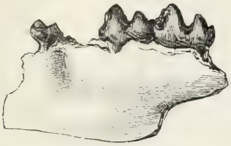

Fig. 1.

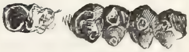

Fig. 2.

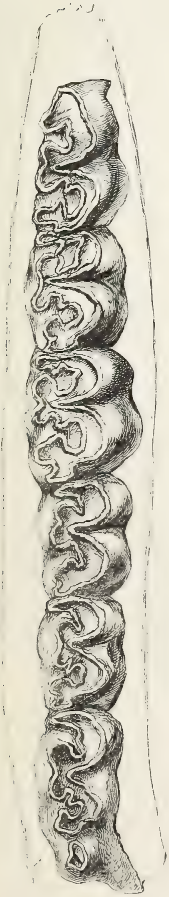

Fig. 3.

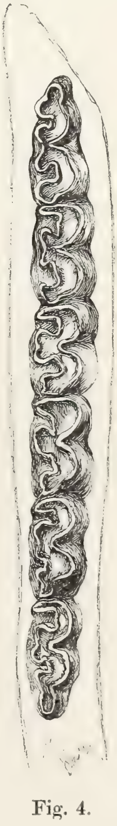

Fig. 4.

1. DIDYMODON VAUCLUSIANUS : 2. Top View of Molars.
(From the specimen, nat. size.)

3 EQUUS MACROGNATHUS (one-fourth linear).

4. EQUUS DEVILLII (one-fourth linear).

S. J. Mackie del.

sures 27mm.; its greatest vertical depth between the penultimate and last molar being 11mm.

The last molar (*m* 3) measures 7mm. in length, and 4 in breadth. Its form is quadricuspid; the two outward cusps being least eroded; from the ectoposterior cusp is developed a slight basal talon, extending towards the entoposterior cusp, which is the smallest of the four, pyramidal, and acuminate; the entoanterior cusp is larger, and is tipped with a small exposed ring of enamel; the ectoanterior cusp is much worn; there is no trace of the distinct hinder lobe of Xiphodon, which lobe in the Dichobune (sp.?) from Hordwell, marked 29714[§] in the British Museum, exhibits a well-marked bicuspid division, having the effect of rendering the ultimate molar in that specimen virtually hexacuspid, to a greater extent than in the *Dichobune ovina.*

The second molar, 7mm. in length and 4 in breadth, has also four cusps; the ectoposterior one being the most worn, and having a distinct basal posterior talon running from it to the foot of the entoposterior cusp; the two anterior cusps are much the highest, a sabre-shaped band of enamel running from the base of the ectoanterior cusp nearly to the summit of the entoanterior cusp.

The fractured first molar has the posterior half broken away beneath the maxillary alveoli; it exhibits the traces of a distinct fang; its anterior portion shows an eroded surface, affording a slight resemblance to the bicrescentic contour of the same part in Dichobune.

I have compared this fossil with the specimens, figures, and descriptions accessible to me of Dichobune, Xiphodon, Cainotherium, Hyægulus, Amphitragulus, Tapirulus, Aphelotherium, Dichodon, Heterohyus, Acotherulum. Of the latter genus, which closely approached Didymodon, Gervais remarks as follows:—"The *Acotherulum saturninum* appears to be related to the Dichobunes; but its hinder molars have only 2 tubercles on each ridge, and in this relation it has most analogy with Palæochærus and Chœromorus, for Dichobune has 3 tubercles on the anterior ridge." Gervais figures, on his 24th plate, the 4 antepenultimate superior molars, and 3 inferior molars of the left side. These were obtained from the lignites of Débruge, near Apt. The lower teeth differ from Didymodon, should my interpretation of their homologies prove correct, by having a distinct quinquecuspid pattern to the 2nd molar, whilst the 3rd molar exhibits (so far as the fractured tooth, half of which is broken away, can yield any decided information) no trace of the well-defined dichotomous division of its posterior portion in the new form.

In *Heterohyus armatus* the last molar is " tuberculeuse, très-émoussée, simulant en avant une fausse colline transverse un peu oblique" (Gervais, pl. xxxv. p. 7), the difference existing between the penultimate and antepenultimate molars of the two forms precluding

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[*] This specimen (No. 29714) consists of the last and half the penultimate molars of a Dichobune; the former measuring 14 mm. in length and 8 mm. in breadth. In the specimen marked 29856 the cusps on the posterior lobe are worn, the breadth as well as the length of the teeth being much smaller than in 29714.

the supposition that any degree of wear could have worn the teeth of Didymodon down to the condition of Heterohyus.

In Dichodon the well-marked bicrescentic form of the molars, and the absence of the tendency to develope 4 pyramidal cusps, with traces of a posterior talon exhibited in Didymodon, render further comparison unnecessary.

In *Aphelotherium Duvernoyi*, Gerv., derived from the Paris gypsum, which bears many curious points of resemblance to Didymodon, and which I only know by Gervais' figures, the view of the 1st and 2nd molars from above (pl. 34. loc. cit. No. 136) presents a totally dissimilar aspect. The two ridges into which the worn molar there depicted is divided, are more oblique than in Didymodon, while the 3rd molar, which in figs. 13 and 13ª is seen concealed in the alveolus, exhibits three distinct ridges.

Tapirulus hyracinus, of Gervais, is another closely allied form. In Gervais' definition of the genus,* he says, "Lower posterior molars with two very distinct transverse ridges, incompletely united by a weak keel perpendicular to their axis, instead of being oblique; a strong posterior talon; that of the last resembling a third ridge less large than the two others." The posterior talon of the hinder molar in Gervais' plate (34, 3 and 3ª) projects far more in a posterior direction than the presumed homologous rudiment in the Didymodon, and this difference is observed in a less degree in the preceding tooth. The ridges in Tapirulus, transverse to the tooth's axis, are too well marked to render it likely that they may have been produced by the worn enamel-folds of the denuded cusps in an old Didymodon.

Hyægulus collotarsus, of Pomel, which in the other dental characters of its lower jaw agrees with the typical Cainotheria,† differs from them, according to that writer, in the deeper division of the inner points of the second ridge of its lower molars. The figure of the species which Gervais presumes to be identical with Hyægulus, and names *Cainotherium Courtoisii* (pl. 35. f. 4, and pl. 34. fig. 6) distinctly shows a third posterior ridge divided apparently into two cusps to the third lower molar tooth. In Chœromorus, from the accessory cusp of the last molar has a tendency to a ternate division, which is seen in the eroded molar of *C. simplex*, and more prominently in *C. mammillatus*. In Palæochœrus, from the accessory cusp, seen laterally, is as high as the two other cusps of the last molar, and even higher than the two median cusps.

Cainotherium, Xiphodon, Dichodon, and Dichobune, each exhibit the same third lobe to the last molar as in Dichodon,‡ repeating the characters of the two previous lobes of the same tooth. In *Dichobune ovina*, this lobe, probably owing to the less degree of wear in the specimens, assumes more the character of an elevated unequal cusp, which, however, as Prof. Owen has pointed out, "plainly consists of a pair of cones; the inner one being rudimentary, the outer one of the same anteroposterior extent as the normal outer cone, but lower and thinner, and oblique in its position." It is this accessory lobe, which in the ruminant division of Artiodactyla is strongly developed.

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* Loc. cit. p. 56.

† 'Geologist,' vol. v. 1862, p. 32 and p. 124.

‡ Owen, 'Quarterly Journal of the Geological Society,' vol. xiii. 1857. pl. iii. fig. 3. The lobe is here marked *g*.

In the *Amphitragulus communis*, from the lacustrine marls of Ronzon, near Puy-en-Velay, the accessory lobe is more outwardly and obliquely developed than in Didymodon, and the same remark applies to the *Xiphodon gracile.*

I have been slowly led to the conclusion that the specimen in question is not to be identified with any of these genera, from the lower Tertiary deposits. At the risk of burdening the overloaded terminology of the fossil herbivorous Ungulates with a new name, I have been led to give it generic distinction. The specific name *Vauclusianum* is derived from the locality.

Should it be placed amongst the Artiodactyles, under which order it seems to be categorized, its place will be found near to Dichobune, Acotherulum, and Aphelotherium. At the same time, there is a certain resemblance to Tapirulus, which should preclude us from confidently denying that it may have perhaps formed part of the family of small pachyderms, congeners of the great Lophiodontoid Perissodactyles.

ON THE AGE OF THE DARTMOOR GRANITES.

By W. Pengelly, F.G.S.

Though our science has risen above the stage from which she taught that all granites are parts of the original crust of the earth; though she has advanced so far as to doubt whether, in all cases, the granitic was the first phase of rock-existence which the materials composing it assumed, and to entertain the question whether such rocks may not be the extreme form of metamorphism, which has obliterated all traces of an earlier condition; and though she may prudently decline to point out, in the large circle of her rocky acquaintances, one mass of crystalline unstratified rock which, as such, can be proved to be older than some known beds of mechanical origin; it remains to be the rule rather than the exception to meet with persons, frequently well-informed, and not without an interest in geology, who still cling to the notion, or allow it to cling to them, that every mass of granite is a *primitive* rock, in the strict chronological import of the term; and represents a period in the earth's history prior to the possible existence of sedimentary strata, or of organized beings. Indeed the opinion that granite is, in all cases, a *primary* rock, has so large a place in the public mind, that one might prudently hesitate before throwing such a question as "What is the age of the Dartmoor granite?" before any audience having a very large admixture of the popular element.

It has long been known that the age of the granitic rocks of Dartmoor can be safely limited on the side of antiquity. That they are less ancient than the culmiferous beds of North and Central Devon has been established on satisfactory evidence produced by various observers.

Sir Henry De la Beche, in his 'Report,' says, "The intrusion of the Dartmoor mass was certainly after the deposit of the carbonaceous series of North Devon, be the age of that series what it may; it thrusts the southern portion of this series northwards to Oakhampton, cuts off the ends of trappean bands and of associated beds of grit and shale near Cristow and Bridford, and sends veins into it in the valley of the Dart, at the junction of the two masses of rock."*

Professor Sedgwick and Sir R. I. Murchison, in their paper on "The Physical Structure and Older Stratified Deposits of Devonshire," say, "Granite veins, passing from the central mass into the superimposed stratified rocks, are found on all sides of Dartmoor. We have seen them above Ivybridge, injected amongst the oldest slates of Devonshire; and near Oakhampton we have seen them in like manner, penetrating the culm-measures; and they are finely exposed in the beautiful gorges of the Teign and the Dart, where those rivers descend from the granite to the culmiferous series. These examples, to which we could add many more, are sufficient for our purpose. Now these veins, taken in general, are mere prolongations of the central granite, inseparable from it, and contemporaneous with it; they cannot therefore (as the granite is one mass) be contemporaneous with stratified rocks of different ages. Consequently they are true veins of injection, and the granite was protruded at a time posterior to all the other stratified systems."† In another part of the same paper these authors go on to say, "It appears that the rocks of Devon and Cornwall belong to three periods of formation. The oldest includes the various groups of slate rocks, and at least a part of the associated traps. The next includes the culm series, the upper division of which contains fossils identical with those in the upper division of the coal measures. The granite belongs to the newest period."‡

Mr. Godwin-Austen, in his paper on "The Geology of the South-East of Devonshire," speaks of similar granite veins, and, in a somewhat qualified manner, confirms the opinion of the authors just quoted respecting the chronology of the granite; stating that "The observation of Professor Sedgwick and Mr. Murchison, above quoted, as to the age of the Dartmoor granite, applies necessarily to the schorly portion alone, which comes in contact with sedimentary deposits, for the entire mass is not of the same age." He then gives a figure of a section, "showing the manner in which the usual porphyritic granite has intruded itself among such as had already become compact and jointed, and containing schorl," and adds, "Again, this porphyritic and micaceous granite is traversed by elvans of a compact, fine-grained stone, presenting no distinct crystallization of any of its constituents, and they have evidently been protruded posterior to the consolidation of the rocks in which they occur. The facts here noticed warrant the conclusion that it (the Dartmoor region) contains granite of three distinct ages." *

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* 'Report on the Geology of Cornwall, Devon, etc.,' p. 165.

† Geol. Trans., 2nd series, vol. v. part iii. p. 686.

‡ Geol. Trans., 2nd series, vol. v. part iii. p. 687.

More recently Mr. Ormerod, who most assiduously uses the facilities which his residence at Chagford gives him for the study of this subject, has mentioned several localities where granite veins occur in the carbonaceous rocks; he states that, at one place on the river Teign, "the veins throw off branches into the adjoining rock, and vary in thickness from a thin filament to a breadth of about eighteen feet." He adds, that "the veins contain portions from the adjoining carbonaceous beds, sometimes so slightly removed from the original position that it can be traced; in the larger veins some of the masses are rounded, as if they had undergone attrition, but some (about a cubic foot in size) still preserve their angularity." †

There can be no doubt, then, that the Dartmoor granites are less ancient than the culmiferous beds of North and Central Devon. Our next business is to find, if possible, a *modern* limit to their age.

Amongst the stratified rocks of the county, the red conglomerates and sandstones, which give such a character to the cliffs and soil of South Devon, succeed, in ascending order, the culmiferous beds already spoken of; they are the next more modern. Now conglomerates may be regarded as natural museums, in which we are likely to find specimens of all pre-existing rocks occurring in their neighbourhood, and the fact that any rock existing in a given locality has no representative fragment in an adjacent conglomerate, though merely negative evidence, would not be a bad, though by no means an unimpeachable, basis on which to found the opinion that such rock is more modern than the conglomerate thus destitute of any indication of its existence. Such an opinion, however, would, of course, be overthrown by the first fragment which further research might bring to light.

Sir Henry De la Beche says, "The evidence of the Dartmoor granite having occupied its present relative position, anterior to the early part of the (New) Red Sandstone, is not always so clear as could be desired; for among all the pebbles of the red conglomerate extending from Torbay to Exeter, we have not been able to detect any portion of it, though the granite ranges so near that part of the red conglomerate. In the tongue of red sandstone and conglomerate which runs from Crediton, amid the carbonaceous series by North Tawton and Sampford Courtney to Jacobstow, we have, however, detected pebbles like some varieties of Dartmoor granite." ‡

It must be confessed that this is not a very pronounced opinion in favour of the North Tawton pebbles being of Dartmoor origin. In his paper, however, in the 'Memoirs of the Geological Survey of Great Britain,' the same author speaks of them in a somewhat more decided tone as follows:—"Among the pebbles of the new red sandstone conglomerate nearest to Dartmoor, granite from it is scarce, some varieties having been only found on the north, by Tawton and Sampford Courtney." *

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* Geol. Trans., 2nd series, vol. vi. part ii. p. 477.

† Quart. Jour. Geol. Soc., vol xv. p. 192.

‡ 'Report on the Geology of Cornwall, Devon, etc.,' p. 166.

Geologists, however, have by no means all concurred in this opinion respecting the so-called "granite pebbles." Thus we find Mr. Godwin-Austen—and probably few geologists are so intimately acquainted with the district—in his paper already quoted, expressing himself thus:—"In the study of detritic formations the identification of mineral fragments becomes of almost equal importance with that of organic remains; in the present instance they afford only negative testimony; but as, from the absence of volcanic fragments in the conglomerate Eocene beds of Central France we infer the relative age of the volcanic outbursts of that region, so, as no granite pebbles have been found among the various materials of which the new red conglomerate is composed, we may conclude, that at the period of its accumulation the granite of Dartmoor could not have been exposed, particularly when we bear in mind that the two formations are at present separated only by the valley of the Teign.

The beds of the greensand of the Haldons and the Bovey valley, in the thin mica, sharp quartzose crystals and seams of felspar clay, suggest that they may have resulted from a decomposed granitic district; but here again, although fragments of all the older rocks occur in the conglomerate beds at the base of the greensand, granitic pebbles are altogether wanting; nor do we meet with them until we arrive, in ascending order, at those superficial accumulations which cap the Haldons, when they appear in great abundance associated with rolled flints, and worn like marine shingle. Possibly, then, the rise of the granite of Dartmoor, in its present form, may belong to a period comparatively recent." †

Sir Charles Lyell says, "The granite of Cornwall is probably of the same date," (as that of Dartmoor) "and therefore as modern as the carboniferous strata, *if not much newer*." ‡ This expression is evidently very guardedly indefinite, much more so probably than would have been the case had that distinguished author been satisfied that the pebbles in question were really granite.

Happening, a few years ago, to be at North Tawton, I mentioned the subject to Mr. William Vicary, then resident there. He immediately took me to the conglomerate, and in a few minutes extracted two or three pebbles, which we both regarded as certainly of Dartmoor derivation. I am not sure that either of us would have contended that they were true granite, if by that term we are to understand a mass made up solely of distinct crystals of felspar, quartz, and mica; nor, thus defined, would any one be prepared to call everything granite which occurs in the true Dartmoor country. Sir Henry De la Beche says, "The granite of Dartmoor is, as a whole, a coarse-grained mixture of quartz, felspar, and mica, the latter sometimes white, at others black, the two micas occasionally occurring in the same mass. It is very frequently porphyritic, from the presence of large crystals of felspar, and here and there schorlaceous; but the latter character is chiefly confined to the outskirts, where the Dartmoor granite adjoins the slates. The schorl not unfrequently occurs in radiating nests of variable size and abundance. A complete passage may generally be traced between the compound of schorl and quartz, usually termed schorl rock, and the ordinary granite. The mica usually disappears as the schorl begins to be abundant, and sometimes, though not very commonly beyond limited areas, the granite is a mixture of mica, schorl, felspar, and quartz, in nearly equal proportions. After the absence of mica the next mineral which commonly disappears is the felspar, leaving the compound a mixture of schorl and quartz, the former sometimes occurring in radiating nests in the latter; but more commonly the two minerals form an aggregate in nearly equal proportions." *

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* Memoirs Geol. Survey, vol. i. p. 228.

† Geol. Trans., 2nd series, vol. vi. part ii. p. 478.

‡ 'Manual of Elementary Geology,' 5th ed. p. 587.

This, though a comprehensive, is by no means an exhaustive description; considerable dissimilarity exists in the size of the aggregated crystals in different specimens; nodules, apparently segregative, sometimes occurring in the substance of the ordinary granite, might, from the fineness of their grain, be almost mistaken for sandstone; indeed, I not long since heard them appealed to as proofs of the metamorphic origin of granite. "Here," said the appellant, "are unaltered remnants of the old sandstone rocks, which, with these exceptions, metamorphism has converted into granite." I do not quote this for the purpose of endorsing it, but simply to show the general dissimilarity of the nodules to granite proper. Excepting their darker colour, they reminded me much of the granite veins which pass through the older granite of Goatfell, in the Isle of Arran; nevertheless they are not veins but nodules, and capable of being extracted, as such, from the granitic mass containing them. Good examples of such nodules may be seen, amongst other places, at Shaptor, about two miles from Bovey Tracey, where I succeeded in extracting two good specimens. They consist of very fine grains of quartz and schorl, in about equal quantities, or with the latter somewhat preponderating.

The observer who enters a Dartmoor quarry soon discovers that granite is by no means weatherproof; the effect of the weather is very discernible, fully a foot or more within the exposed surfaces; a more or less dark or ferruginous-looking band, of about the width just mentioned, graduates into the unchanged rock, and suggests that small fragments might, through long exposure and rough usage, undergo a very considerable change of aspect.

The boulders which occur so abundantly in the beds of the Dartmoor rivers and rivulets are found to be more or less changed in

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* "Report," p. 157.

character; were it not that every gradation can be readily supplied, it would be sometimes, at least, a little puzzling to recognize a member of the Dartmoor family of rocks in the fragments met with along the river-courses, and which have yielded to the various influences to which they have been exposed since leaving home. It is these travelled masses which must tell us whether the red conglomerates of Devonshire contain specimens derived from the central upland of the county; and I have no hesitation in believing that every one approaching the subject in this way would pronounce the North Tawton pebbles to be of Dartmoor origin.

In August last (1861), I met Mr. William Vicary,—who now resides at Exeter, and is devoting himself, with great diligence and success, to the geology of that neighbourhood,—and again introduced the subject of the North Tawton pebbles; on which he informed me that he had recently found unmistakable Dartmoor fragments in the red conglomerate of Great Haldon, a well-known hill about five miles south of Exeter; and that a friend, to whom he had mentioned his discovery, had called his attention to the following passage in Brice's 'History of Exeter.' The author is describing the Haldon red conglomerate, and says, "*In it* we have often found rounded pebbles, and *pieces of granite of the same form*."*

A fact of so much interest was not to be neglected; accordingly we took an early opportunity of starting for Haldon. Passing through Alphington and Kennford, and leaving the great road from Exeter to Plymouth by Chudleigh and Ashburton, on the right, for that which passes over Haldon, in a more easterly direction, to Newton-Bushel, we reached our ground, about five miles and a half from Exeter; and Mr. Vicary at once pointed out one or two well-marked fragments of the true Dartmoor series of rocks in the conglomerate, but so far decomposed and disintegrated that it was impossible to extract them in their integrity; a further search was soon rewarded with several less perishable specimens, amongst them representatives of each kind of granite recognized by Mr. Austen in the Dartmoor country; namely schorlaceous granite, porphyritic granite, and elvan.

On our way back to Exeter, we detected two or three well-marked specimens near Peamore, about two miles and a half from the city.

That part of Haldon at which the pebbles are met with is about five miles, in a straight line, from the nearest point of the granite; the fragments found at Peamore must have travelled something more than a mile further. The red conglomerate approaches to within about the same distance from the granite at Newton-Bushel, and several other places; the fact, if it be one, that no such pebbles have been found in these localities, should stimulate to further and careful search; and if, after all, they really do not exist there, it need not be a matter of very great surprise; changes in the physical geography of the district, amply sufficient to account for it, may have occurred since the period of the red conglomerate.

I may state here that during the spring of the present year (1861),

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* 'History of Exeter,' by Thomas Brice, 1802, p. 114.

Dr. Daubeny pointed out to me certain pebbles, which he thought granite, in the red conglomerate at Livermead, in Torbay; my own impression, however, is, that they are trap. I do not, of course, suppose that my opinion would be of any value when opposed to that of the eminent man just named, especially on a point of this kind. I merely mention the fact, to show that I have not allowed a strong bias, supposing me to have one, to overrule my judgment; or I should have quoted the Livermead pebbles as granitic, on Dr. Daubeny's authority.

But waiving this point, I cannot regard it as certain that the red rocks of Torbay and of the South Devon coast generally are entirely destitute of Dartmoor detritus. Every one who has paid attention to the sandstones there, must be well aware that in many cases they are eminently micaceous; this is very noticeable at the Corbons and Livermead Head, in Torbay, where every newly exposed surface glistens with an almost metallic glance, from the presence of numerous large scales of black mica; doubtless a result of the destruction of a large amount of pre-existing rock, of which mica was a constituent. It is, no doubt, true that certain gritty members of the older rocks of the county sometimes contain scales of mica; it seems impossible, however, that these can have been the source of those found in the Red Sandstone, for, so far as I am aware, they are, in the first place, always small instead of large; and, in the second place, invariably white instead of black. On the other hand, in a passage already quoted from Sir H. De la Beche's "Report," it is stated that the mica of the Dartmoor granite is sometimes black. Nor is it difficult to understand that whilst pebbles and boulders might be unable to force a passage to what is now the South Devon seaboard, comparatively small thin flakes of mica succeeded in accomplishing the journey. The fact, however, that nodules of micaceous trap occur in the conglomerate, renders it manifestly unsafe to insist on the granitic derivation of the scales in the sandstone.

If it be true that granite pebbles occur at Sampford Courtney, North Tawton and Haldon, but do not exist on the southern coast of the county,—in other words on the north and north-east, but not on the east, of Dartmoor,—may we not have, in this fact, an indication of the prevailing direction of the most powerful currents, or other agents of transportation, in this part of modern Devonshire during the Red Sandstone era?

The following appears to be a strikingly parallel case. The low plain known as Bovey Heathfield, in Devonshire, is covered with a very coarse gravel, and surrounded, on almost every side, by hills of considerable elevation; on the north and west the granite heights of Dartmoor, fringed with traps and metamorphic rocks; on the north-east and east the greensand hills of the Haldons, capped with vast accumulations of flint and chert; and on the south a range of hills, extending from Newton towards Ashburton, consisting of Devonian limestone and associated rocks. The Bovey gravel consists almost entirely of Dartmoor material, a flint or chert fragment occurring here and there at very long intervals. I will not undertake to say that it contains no limestone detritus, but I certainly have never seen or heard of a fragment of the kind, though I have frequently, and with considerable care, examined the gravel, and questioned the men who work amongst it; yet the limestone is one of the oldest rocks of the district. Accepting this negative evidence as trustworthy, it simply proves that the direction of transportation was not from the south; not that the rocks in that direction have been called into existence since Bovey Plain received its surface covering.

But to return. The facts now in our possession appear to compel the belief that the Dartmoor granites were not in existence when the carboniferous rocks of Central and North Devon were deposited, but did exist and were exposed at the surface in the red conglomerate era. In relation, then, to the stratified rocks of the county, we have both an ancient and a modern chronological limit for the granites. Our next question is, What are the places of the limiting rocks in the chronological series of the geologist?

There is no difficulty as to the answer respecting the *ancient* limit —the carboniferous beds. Professor Sedgwick and Sir R. I. Murchison, in their paper already quoted, say "the *flora* of the upper culms, as far as it has been ascertained, agrees specifically with the known flora of the Carboniferous period. We think we have strong direct evidence to establish our position that the upper culm strata of Devon are the geological equivalents of the ordinary British coalfields."* The same authors, in a passage previously quoted, state that "the upper division of the culm series contains fossils identical with those in the upper division of the coal-measures."

It is not so easy to settle the *modern* limit—the red sandstones and conglomerates. That they belong somewhere between the Carboniferous and Jurassic systems there can be no doubt, since they overlie the culmiferous beds and pass under the Lias; but whether they are Triassic or Permian has not been considered so certain as could be desired. They are entirely destitute of fossils, excepting those only which occur in the calcareous pebbles, which, of course, belong to the age of the parent limestone. The sandstones are evidently of littoral origin; their surfaces frequently display *wave*-ripple marks, desiccation cracks, and impressions of rain-drops; but no footprints or other organic traces have ever been detected on them; they apparently contain no palæontological evidence whatever of their age.

More than one eminent geologist has been struck with the angular character of the fragments composing the so-called conglomerate, —more correctly, breccia,—and has remarked that in its physical character and general appearance the formation is rather Permian than Triassic. It is, however, as is well known, coloured on our geological maps as being on the horizon of the lower Trias. I am not without hopes than the granite pebbles so frequently mentioned here may help to show that this decision is correct.

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* Geol. Trans., 2nd series, vol. v. part iii. p. 682.

Whatever may be our opinion respecting the origin of granite,—whether we hold it to be a strictly igneous or a thermo-aqueous product, an original or a superimposed phase of rock existence,—we are probably all agreed that it was formed in plutonic depths, a hypogene formation requiring for its elaboration enormous pressure, and therefore at least commensurate resistance in a superincumbent crust. In the case before us, the overlying mass existed at the close of the Carboniferous period, or the granitic form could not have been assumed by the Dartmoor rocks; and it must have been removed and the granites laid bare before the conglomerate era, or fragments of the latter could never have found their way to Haldon.

Mr. Sorby estimates the pressure under which the St. Austell granite was formed as equivalent to that of 32,400 feet rock; that of the mean of the Cornish granite at 50,000 feet; and that of Dingdong Mine, near Penzance, at 63,000 feet. He gives no estimate for Dartmoor, but taking his *lowest*, the St. Austell figures, we have a pressure equivalent to that of a pile of rock six miles in thickness; but, since the pressure was probably due to the expanding power of some agency acting beneath or within the granitized mass,—requiring resistance and not pressure, strength and not weight in the overlying crust,—we will content ourselves with a small fraction of this: nevertheless there must have been a solid crust of vast thickness for denudation to strip off before a granite pebble could have travelled to Haldon. Even if we suppose that some paroxysm uplifted the granite in a solid state, so as to shiver the overlying masses, and thereby facilitate the work of denudation, still the removal of such a mass of rock must have required an amount of time so vast, that it seems totally impossible to regard the red conglomerates and sandstones as more ancient than the Lower Trias; and, even thus, what an incalculably great value does this stamp on the units of geological chronology!

The supposition, however, that the granite was thus thrust through the overlying rocks is altogether improbable, for the latter appear to have shared in all the great movements which the former may have undergone. According to Sedgwick and Murchison, the granite veins in the older surrounding rocks, "taken in general, *are mere prolongations of the central granite, inseparable from it,* and contemporaneous with it."*

The time of denudation, moreover, vast as it probably was, formed but a fraction of the period separating the culmiferous and red rocks. At the close of the Carboniferous period there was no Dartmoor granite; after this we have, according to Mr. Godwin-Austen, the formation of three distinct masses of granitoid rocks, very distinguishable from one another, clearly results of dissimilar conditions within the same area, and therefore referable to different times. The *schorlaceous* granite was first formed; this was succeeded by the *porphyritic* variety when the first had become compact and jointed; afterwards the *elvans* were formed and obtruded into the porphyritic mass subsequently to its consolidation;* then followed the period of denudation; but all this was anterior to the commencement of the conglomerate era, since pebbles of each kind of granite occur in the Haldon beds, which belong to the base of the red rocks of Devonshire.

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* Geol. Trans., 2nd series, vol. v. part iii. p. 686.

Should it be objected that the granites, though requiring great pressure, were not necessarily formed beneath an accumulation of *rocky* matter, but possibly under an equivalent depth of sea, it does not appear that this can greatly affect the chronology of the question, at least by way of abridgment. Passing by all other considerations, we should require a lapse of time sufficiently great to carry down the area of, at least, central Devon, from the relatively high level at which the culmiferous beds were certainly deposited, to an ocean depth of enormous profundity; and time enough, too, after the plutonic masses had, at this depth, been called into existence, to bring it up again within the influence of the waves, so that they might detach samples of each kind of granite, to be transported to where the conglomerate was being formed.

Take what view of the case we may, an enormous period between the culm and conglomerate series appears inevitable; a period during which great changes were effected within, and on, the crust of the earth —changes which, from their nature, could not have been contemporary, but must have followed each other in a definite and ascertained order, and the greater part of which at least convulsion or catastrophe must have been powerless to produce or hasten.

Unless we assume that a great chronological interval elapsed between the Carboniferous and Permian periods,—and to this palæontology appears to give no sanction,†—the facts of the case before us seem to require the belief:—

1st. That the granites of Dartmoor are not older, at most, than the close of the Carboniferous period.

2nd. That they had been stripped bare by denudation when the materials of the red conglomerates were being brought together.

3rd. That the red conglomerates and sandstones are not of higher antiquity than the Lower Trias.

4th. That the Permian period was of great duration.

ON THE MODE OF FORMATION OF LIMESTONE BANDS.

By Rev. J. D. La Touche, *Stokesay, Salop.*

With a Note by J. W. Salter, F.G.S., A.L.S.

The existence of layers of limestone at various intervals among the rocks, while in the intermediate strata there is a remarkable deficiency of that substance, is a fact which I have not seen hitherto satisfactorily accounted for, but of which we may hope to find some rational explanation.

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* Trans. Geol. Soc., 2nd series, vol. vi. part ii. p. 477.

† Page's 'Past and Present Life of the Globe,' p. 114.

The surface of the country in Shropshire, where these rocks abound, may be roughly described as consisting of ridges of hills, of which one flank is steep, the other shelving; the crest of the ridge being composed of a band of limestone, which, by its hardness, has evidently resisted the action of the denuding forces which have worn away the softer strata, and thus have formed the valleys.

I. Now, while the proportion of lime to earthy matter is immensely great in these comparatively thin bands which form the crests of these hills, it is as remarkably deficient in the rest of the strata; in the one case, the fossils, and their bed also, are often found to be a mass of carbonate of lime, while, in the other, not only the substance in which the fossils are deposited is deficient in that substance, but the fossils themselves have frequently lost the lime which once, beyond all doubt, entered into their composition.

II. Besides these remarkable and extensive layers of limestone, we meet occasionally with minor bands of more limited extent, and in some places with *nodules* of limestone varying from an inch or two to eighty feet in diameter.

Such, briefly, are the facts of the case, and attempts have been made to account for them in the following manner :—1st. It has been supposed that occasionally, during the deposition of the strata, a sudden but transitory development of carbonate of lime took place in the waters of the primæval seas—an hypothesis which seems to be at once refuted by the existence of the nodules I have alluded to: and, 2ndly, a more plausible theory, that these bands have been formed in a manner analogous to coral reefs; that the animals of which the fossils are the remains, secreted vast quantities of lime; that an accumulation of that substance took place around them, and so ultimately a layer of limestone was formed.

The last hypothesis seems to me also unsatisfactory, for while it may account for those cases where fossils are enormously abundant, as in some parts of the Wenlock limestone, it seems to fail in those where they are absent; and such instances are frequent. We find large masses where fossils are rare, and yet that they have not been destroyed or absorbed in any way is proved by the existence of occasional specimens in a very perfect state. Witness such fossils as the *Illænus Barriensis;* the *Euomphalus,* and other shells at Woolhope, preserved perfectly in the midst of an enormous bed of limestone. And does this hypothesis give any satisfactory account of the nodular masses? Can they be supposed to be formed in the same way as coral reefs?

Altogether, the facts above mentioned seem to me to point to some kind of aggregation of particles, like to like, probably *after* the deposition of these strata. While they were in the transition state between mud and rock, the limestone particles which had been equably distributed throughout them arranged themselves in definite layers to form strata, or round certain centres to form nodules, in a manner analogous to that in which metals crystallize themselves from their vast dispersion throughout the substance of the globe. It is quite true, we know but little of the effects of such forces, exerted incessantly during countless ages, but we have good reason to believe that they have acted; and may we not, with some probability, refer to them such phenomena as I have described?

Let it be remembered, that two distinct facts demand explanation:—1st, the preponderance of lime in certain comparatively thin strata; and, 2ndly, the not less remarkable absence of lime in strata enormously thick. Are not these facts correlative? Is it not probable that the lime which once composed part of the fossils in the earthy strata has been agglomerated in these bands and nodules, by a process on a large scale analogous to that which takes place in the formation of flints, and, in some degree, like the aggregation of the metals?

Dear Sir,—I enclose the above suggestive note by my friend the Rev. J. La Touche, a working geologist, trained in the the Ludlow school.

I cannot say I agree with him in his larger generalization, for there is no doubt whatever of the actual deposit of these beds of limestone, again and again, over the same area, with interruptions marked by the deposit of shale. Nay, strange as it may seem, the beds of limestone, crammed with fossils, often alternate closely with beds of shale, in which one can hardly detect a fragment of a fossil. In these, and in most cases, I believe, a band of limestone means—a period of "rest." The shale beds are signs of a more turbid action of the water.

But then, his observation is a good one for a great many cases. No one who has studied the old limestones can believe they were deposited quite as we now find them—full of strange lenticular shapes, now crowding out the shale beds, now completely enveloped in them. Such cases as the following are not at all uncommon.

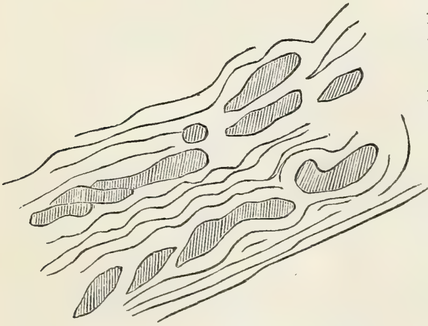

Fig. 1.—Nodules of Limestone in Shale.

We may be well assured of two things:—1. There *was* a bed of limestone, for the nodules lie in horizontal planes, and are made up of fossils in many cases. 2. The subsequent action has increased the size of the limestone band, and given it a nodular form by attraction round central points.

The old proverb, "He that hath shall have more," is, I believe, strictly applicable in such cases. The band, comparatively rich in lime, has served as a point of attraction for neighbouring small quantities of lime, precisely as my friend suggests. And, really, the analogy with flints, and not remotely so with metals, is much to the point.

I had lately before my eye a thick series of nodular limestones in that little-known formation, the carboniferous slate. A rough drawing of it might be thus given :—

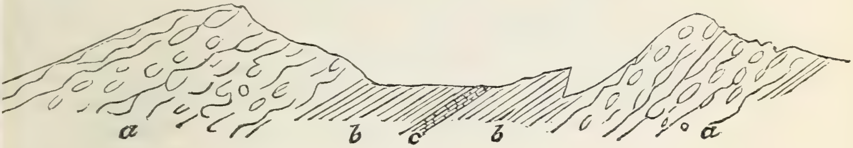

Fig. 2.

Here were thick beds, 28 feet and 25 feet respectively, of nodular limestone among shale, separated by a thick band of shale, *b c*, without limestone, or, rather, with only a uniform distribution in small proportion to the mass; and a flat bed of lime in the middle, *c*.

But the nodules were extremely regular—the projection of one fitting opposite the recess of another, and the shale between following these sinuosities. These could never have been the lines of original deposition. Moreover fossils, though plentiful enough, did not form the mass of the limestones *a*. Here segregation is evident enough.

It is the commonest of all phenomena to meet with beds of lime-stone in which the lenticular form prevails, and to find such beds crowded with fossils. Here we have the result of the two causes—plain deposition and subsequent segregation. The base of the mountain limestone group gives excellent examples of both. The beds are one mass of shells and encrinites, and in them, disposed in every fanciful form, and yet in layers on the whole, are nodules of chert.

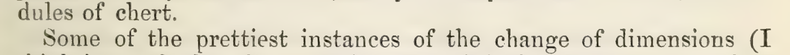

Fig. 3.

Some of the prettiest instances of the change of dimensions (I think it was Sorby who applied the term) in limestones occur when the rocks containing them are cleaved. In such cases, where cleavage is well-developed, the limestone nodules will often form along the cleavage, *i. e.* the line of least resistance. In cases where great pressure has been exerted, the bed of limestone is often violently crumpled up, while the shale has quietly submitted to be squeezed, and "made no sign," though every layer of it must have undergone the same process. I have, in my sketch-book, a Devonian limestone bed, near Ilfracombe. Here are two lines of original deposit; *a* and *b* were limestone bands, and are full of encrinites, but the thickness of neither *a* nor *b* can be determined except by calculation; the bed is squeezed into nothing in one part, thickened out to thrice its original diameter in another. The mass has changed its dimensions; and a limestone band could not have done this without a rearrangement of its particles. This is, in part, what Mr. Latouche means. However, we must combine the two ideas: original deposit, as bands of limestone, of which we have abundant instances—the whole mountain-limestone to wit—with that of a very frequent, nay, I am inclined to believe, all but universal—alteration, and segregation afterwards. In this way we may account for nearly all the vagaries of limestone—and they are neither few nor small. The arrangement of the shale itself in layers parallel to these concretions, nodules, and irregular layers, is yet more difficult of explanation, Yet it is certain. It is foliation on a small scale. Are the rocks never at rest?

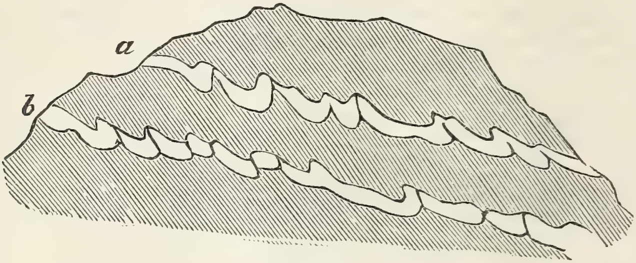

Fig. 4.

J. W. Salter.

ON THE GEOLOGICAL EVIDENCES OF HORSES IN THE NEW WORLD.

By Charles Carter Blake, Esq.,

Lecturer on Zoology at the London Institution.

Before attempting to deduce any general conclusions respecting the geological evidences of the genus *Equus* in the New World, it is necessary to have clear ideas respecting the geographical distribution of its members. In the first place, therefore, I give a sketch of the classification and range of the existing species.*

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* Much information may be derived from the works of Owen, Gervais, Gay, Gray, Hamilton Smith, Crawfurd, Darwin, Leidy, Lubbock, Pictet, Bronn, Falconer, Sclater, Bartlett, Nott, Gliddon, Blyth, Laird, Sykes, Youatt, Schreber, Wagner, and others, and at the end of this series I shall give a list of the authors to which I have referred.

In the geographical distribution of animals into provinces, I follow the philosophical arrangement proposed by Dr. P. L. Sclater, who has applied the classification to ornithological arrangement with so much success.

	Palæarctic.	Ethiopian.	Indian.	Australian.	Nearctic.	Neotropic.
Equus caballus	+	—	—	—	—	—
Equus asinus	+	—	—	—	—	—
Equus onager	+	—	+	—	—	—
Equus hemionus	+	—	+	—	—	—
Equus equuleus ?......	—	—	+	—	—	—
Equus quagga	—	+	—	—	—	—
Equus Burchellii......	—	+	—	—	—	—
Equus zebra	—	+	—	—	—	—

The following species are of doubtful specific value:—

	Palæarctic.	Ethiopian.	Indian.	Australian	Nearctic.	Neotropic.
Equus varius	—	—	+	—	—	—
Equus hippagrus ...	—	+	—	—	—	—
Equus hamar	+	—	—	—	—	—
Equus antiquorum ...	—	+	—	—	—	—
Equus isabellinus? ...	—	—	—	—	—	—

The geographical distribution of fossil horses was as follows:—

	Palæarctic.	Ethiopian.	Indian.	Australian.	Nearctic.	Neotropic.
Equus fossilis	+	—	—	—	—	—
Equus plicidens	+	—	—	—	—	—
Equus piscenensis ...	+	—	—	—	—	—
Equus palæonus	—	—	+	—	—	—
Equus sivalensis	—	—	+	—	—	—
Equus Namadicus ...	—	—	+	—	—	—
Equus curvidens......	—	—	—	—	—	+
Equus neogæus	—	—	—	—	—	+
Equus Chilensis	—	—	—	—	—	+
Equus nearcticus......	—	—	—	—	+	—
Equus asinus fossilis		—	—	—	—	—

The geological distribution of fossil horses was—

	Eocene.	Miocene.	Pliocene.
Equus palæonus	—	+	—
Equus sivalensis	—	+	—
Equus Namadicus ...	—	—	—
Equus fossilis	—	—	+
Equus plicidens	—	—	+
Equus piscenensis ...	—	—	+
Equus curvidens	—	—	+
Equus neogæus	—	—	+
Equus Chilensis	—	—	+
Equus nearcticus......	—	—	+
Equus asinus fossilis	—	—	+

EQUUS FOSSILIS, *V. Meyer, Palæologica, 8vo,* 1832, *p.* 79. *Owen, British Fossil Mamm. p.* 383.

The common British fossil horse, evidences of which are so common in our bone caves and pliocene deposits, Professor Owen states to have been characterized by a larger head than the domesticated races; resembling, in this respect, the wild horses of Asia described by Pallas, and in the same degree approximating the Tebrine and Asinine groups. He also points out that the second and third molars of both jaws are narrower transversely in comparison with their anteroposterior diameter than in the existing horse; a character which, although present in the teeth derived from the Kirkdale Cave, Oreston, and the newer pliocene blue clay at Cromer, was absent in some of the Kent's Hole specimens. With respect to the more important characters of the degree and mode of plication of the enamel folds, no specific differences are demonstrated by Professor Owen between the *E. fossilis* and the *E. caballus*. The range of variation, however, amongst the existing horses, is as yet undetermined; and I purpose, at a future time, to institute an accurate comparison, which would be, however, beyond the scope of the present paper. In Norway, I am told, on the authority of Mr. A. D. Bartlett, F.Z.S., that there still exists a breed of horses with traces of the zebra-striping on the legs. It would be a most fruitful source of information if the teeth of these horses were to be compared with those of the fossil European species; and I doubt not but that the perseverance of the Superintendent of the Zoological Gardens will be crowned with success, in obtaining living specimens of this breed.

Colonel Hamilton Smith divides the species *E. caballus*, or true horse, into four distinct origins: (a) the bay wild horse, or Tarpan; (b) the white villous wild horse; (c) the black wild horse; (d) the Eelback, dun decussated.

Characters.—Hitherto undetermined.

Geog. Distrib. Northern Europe.—*Geol. Age.* Pliocene.

EQUUS PLICIDENS, *Owen, Brit. Foss. Mamm.* 392; *Report Brit. Ass.* 231. (First upper molar, second upper molar, right lower canine (juv.) astragalus, hoof phalanx.)

Characters.—Enamel more complex than in *E. caballus;* crown of last upper molar bilobed posteriorly, as in *Hipparion*, from which it differs in the form of the fifth or internal prism of dentine in the upper molars, and in its continuation with the anterior lobe of the tooth; differing, like *E. fossilis*, from *E. caballus*, in greater anteroposterior diameter of crown of second upper molar, and less produced anterior angle of first molar. (Owen.)

Geog. Distrib. Oreston cave.—*Geol. Age.* Pliocene.

Professor Owen says on this, "One cannot view the elegant foldings of the enamel in the present fossil teeth, and in those of the more ancient primigenial species (*Hippotheria*) of the Continental Miocene deposits, without being reminded of the peculiar character of the enamel of the molar teeth of the *Elasmotherium*, in which it is folded in elegant festoons." It is indeed a singular fact, although one accountable on a known biological law, that the more ancient species of *Hipparion* and *Equus* should exhibit the more generalized type of perissodactyle dentition.

EQUUS PISCENENSIS, *Gervais, Zool. and Paléontol. Françaises, p.* 67, *pl.* 21, *figs.* 9, 10. (Upper portion of the cannon bone of the forefoot; first phalanx.) This species, smaller than the horse, has been founded by M. Gervais on the above bones of the extremities. The teeth are wholly unknown.

Geog. Distrib. Right bank of the Riége, near Pézenas (Herault). —*Geol. Age.* Pliocene.

EQUUS PALÆONUS, EQUUS SIVALENSIS, EQUUS NAMADICUS.—These three species are figured in *Falconer and Cautley's* '*Fauna Antiqua Sivalensis*,' but no description is there given. The figured specimens are in the British Museum.

EQUUS CURVIDENS, *Owen in* '*Fossil Mammalia of the Voyage of the Beagle*,' *p.* 108, *pl.* 32, *figs.* 13, 14.

Characters.—Molar teeth left side upper jaw, slightly smaller and more curved than *E. caballus*. A superior molar of the right side was derived from Bahia Blanca, but its friable condition precluded its representation in Professor Owen's work.

Geog. Distrib. Punta Alta (Bahia Blanca), Santa Fé in Entre Rios. —*Geol. Age.* Pliocene.

EQUUS NEOGÆUS, *Lund.—Syn.* Equus macrognathus (*Weddell, p.* 204). E. principalis, *Lund, Ann. des Sci. Nat.* xii. *p.* 309. Equus Devillei, *Gerv.*

Mr. Lund, the founder of the species, characterizes it by the greater breadth and flatness of the metatarse than any existing horse. The name *macrognathus* is founded on the greater length of the *diastema* in the Tarija specimens. The two lobes of the lower molars are more distinctly separated than in the *E. caballus*, although there is no interruption in the ribbon of enamel.

Castlenau calls attention to their more generalized type in the following words:—"Before the crowns are worn, the thickness of the cement gives them a rather peculiar appearance, which makes them, up to a certain point, resemble those of *Rhinoceros*, because the arched form of each of their lobes is then more apparent, and because the ends of each curve are prominent in a tubercular form."

Equus Devillii is not characterized by Lund, but Gervais figures a fragment of lower jaw, and an astragalus, the proportions of which are different from those of *E. neogæus*. The differences in the molar teeth are however very slight.

Geog. Distrib. Tarija (Bolivia, Brazil).—*Geol. Age.* Pliocene.

EQUUS CHILENSIS.—*Syn.* Equus Americanus (*Gay*, i. 146). (Third lower molar, left side.)

Characters.—Molars as large as those of *Equus caballus*, and perhaps a little thicker: having the same general arrangement of enamel, dentine, and cement as it, but differing in some minor modifications. Thus, the conformation of the curves (*las redondeces colocadas*) attached to the inner border of the crown is somewhat more broad, and the space in the little isthmus which joins the first and second of these inner curves to the two oval ones outside, is also more broad and with plications less crenulated (*frisado*). (Gay, *loc. cit.*)

Geog. Distrib. Taguatagua lagoon (*Gay*).—*Geol. Age.* Pliocene.

Equus nearcticus.—*Syn.* Equus Americanus (*Leides*).

Characters?—I am yet unable to form any distinct idea as to this species from the few figures and descriptions I have seen. The name *Americanus* is, however, glaringly inappropriate; as also, in a less degree, are those of *E. neogæus* (which should be *neotropicus*), and *Chilensis* (a name which the discovery of the species elsewhere would nullify). Names like *curvidens, plicidens, macrognathus,* are much more convenient, as they give a more or less distinct idea of the characters of the fossil.

Geog. Distrib. Confederate and Federal States.—*Geol. Age.* Pliocene.

The problem which we have to solve is, whether the *E. Chilensis, neogæus,* and *curvidens* are distinct species. Gervais, in Castelnau's work (page 33), assigns them all to one species, of which he retains the name *E. neogæus.* He however separates *E. Devillii* with an expression of doubt, saying that "slight differences in the form of lower molars, and a smaller size than that of *Equus neogæus,* are the only characters which we can yet assign to it. Its smaller size seems to exclude the possibility of its similitude with *E. principalis,* of which the undiagnosticated name appears to indicate a certain superiority in relation to the other animals of the same genus."

The fragment of lower jaw belonging to *E. Devillii* bore the six principal molars. These teeth are small, with less coronal complexity, and remarkable for a little different disposition of the *boucles internes* which the enamel forms inside each lobe. The total length of the six molars is only 0·160, instead of 0·195; the first tooth, separately, measures 0·030, instead of 0·035, in the *E. neogæus;* the fourth, 0·024, and the sixth, 0·030. I cannot coincide with M. Gervais in considering these differences specific.

The question, whether *Chilensis* and *neogæus* are identical, next comes before one. In order that my readers will appreciate the difficulty, I figure 76 from Gay's 8th plate, and 4 *a* from Castelnau's 7th plate. The first is *E. Chilensis,* the second *E. neogæus.*

E. curvidens (Owen) I am unable specifically to distinguish from *E. neogæus.* I figure the corresponding teeth.

The object of this brief note is merely to point out that the time is not yet arrived when any general proposition can be laid down respecting the geographical distribution of horses in the New World. As regards their geological age, they are all from later tertiary, probably pliocene or pleistocene deposits. None of the South American species offer any points of resemblance to the genus *Hipparion,* or three-toed horse of the Old World. No species of *Hipparion* has yet been discovered in America.

Explanation of the Plates.

Pl. II. Fig. 3, *Equus macrognathus;* fig. 4, *Equus Devillii.*

Pl. III. Fig. 1, *Equus Chilensis;* fig. 2, *Equus macrognathus;* fig. 3, *Equus macrocephalus.*

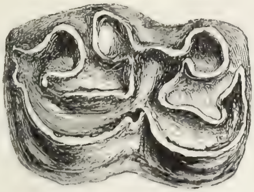


Fig. 1.

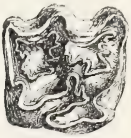


Fig. 2.

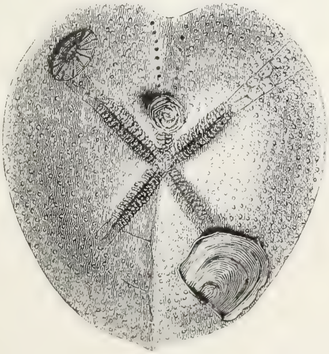


Fig. 6.

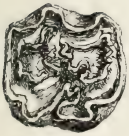


Fig. 3.

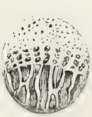


Fig. 4.

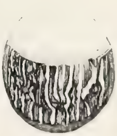


Fig. 5.

Fig. 1. EQUUS CHILENSIS (Molar). 2. EQUUS MACROGNATHUS (Molar). 3. EQUUS DEVILLII (Molar). 4. HOLOPTYCHIUS (Scale). 5. GLYTOLEPIS (Scale). 6. MICRASTER COR-ANGUINUM, Chalk, Dover.

S. J. Mackie del.

ANALYSIS OF THE RED CHALK OF HUNSTANTON, ON THE COAST OF NORFOLK.

By R. Calvert Clapham, Esq.

During one of the excursions of the late meeting of the British Association at Cambridge, the red chalk of Hunstanton was examined, and as I am not aware of its having been previously analysed, I obtained a specimen to analyse.

The bed of red chalk is about 3½ feet thick, and runs along the coast, distinctly seen for some miles. It rests immediately upon the Greensand, and above lies a bed of white chalk, varying in thickness from 25 feet downwards.

Professor Phillips, of Oxford, informs me that this bed of red chalk has been traced from Speeton, in Yorkshire, to Spilsby, in Lincolnshire, and reappears at Hunstanton, in Norfolk.

It contains many fossils, chiefly of the White Chalk, and also fossils of the Greensand and Gault.

It is an interesting question to consider what is the cause of colour in the red chalk. Professor Phillips thinks that it is derived from decomposed glauconite or decomposed augite (both of which contain protoxide of iron and magnesia). It may also be caused by decomposed iron pyrites, as it will be observed it contains a trace of sulphate of lime.

At Speeton it is in some places a soft red clay, and is used to colour bricks and rough pottery.

The following is the analysis :—

	Red chalk.	White chalk.
Carbonate of lime	80·04	95·80
Sulphate of lime	0·10	trace only.
Peroxide of iron	9·60	1·08
Alumina	1·42	0·52
Magnesia	nil.	0·48
Silica	9·28	2·28
Manganese	trace.	0·11
	100·44	100·27

Walker, Newcastle-on-Tyne, November, 1862.

CORRESPONDENCE.

Ages of Mineral Veins.

Sir,—Upon reading your report upon Mr. Moore's paper on the "Palæontology of Mineral Veins, etc.," before the British Association, a circumstance bearing upon the question occurred to my recollection, which I would have mentioned had I been present in the Section at the time the paper was brought forward. Mr. Moore shows that lead veins in the

Mendip district and elsewhere reveal contents of Secondary age. I noticed many years ago, when the railway was being made from Frome to Radstock, that lead ore had been present in the inferior Oolite, where it reposes immediately upon the Carboniferous Limestone, at a spot near the letter "k" in the word "Pike" on the Ordnance map, about a mile (to scale) north of Frome. If my memory serves me, the ore occurred in veins in joints in the Oolite. This proves that, even if the lead veins of that district are not wholly of Secondary age, at any rate the deposit of ore was not *concluded* until after the deposition and solidification of the inferior Oolite. I am, Sir, faithfully yours,

O. Fisher, F.G.S.

Elmstead, Colchester, Nov. 10.

Druid Sandstone.

Dear Sir,—In your last number of the 'Geologist,' page 450, Mr. Bensted makes the remark, that the statement of Dr. Mantell still holds good, that no regular stratum of the Druid Sandstone has yet been discovered in this country; and its geological position is still undetermined.

The following observations will, I believe, throw some light upon this question. Close to the village of Broodmayne, about five miles from Dorchester, on the Wareham road, are several blocks of Druid Sandstone, in two fields on each side of the road, close to a farmhouse, marked "Little Mayne" on the map. These blocks have been a puzzle to the local archæologists, who have endeavoured to give them an antiquarian value, and to explain their arrangement as belonging to some ancient so-called "Druidical" work. They are however a natural deposit, and as I conceive, are, so to speak, *in situ;* that is to say, they have not travelled any distance from the place where they were formed. The locality is on the line of junction with the Chalk of a small outlier of the Lower Tertiaries. These beds are extremely variable in character, and at this spot a fine sharp white sand crops out on the north side of the shallow valley in which the blocks lie. In the side of the road this sand has been cut into, and two of the blocks of sandstone are seen, one partly cropping out on the surface, with its lower portion embedded in its native sand. The other is entirely enveloped in the sand, except as far as it has been exposed in cutting the road.

The blocks are evidently indurated masses, or septaria of this bed of sand.

The denuding forces which have scooped out the valley, have removed the sand and left the blocks behind.

There are numerous other blocks of a similar character on and beneath the lofty hill called Blackdown, near Portisham. These however are conglomerates of large flints. Some lie on the top of the hill on the upper surface of the chalk, almost *in situ*, as at Mayne, and close to the Tertiary beds from which they came; others have been carried by some torrential action into the deep valleys of Portisham and Bridehead beneath.

I remain, faithfully yours,

O. Fisher.

Elmstead, Colchester, Dec. 10.

Restoration of Pteraspis.

My dear Sir,—Mr. Lankester, in referring in your last number to a paper of mine, in your November number, has given us two sketches of specimens of Pteraspis and the restoration of the test by Professor Huxley. Substantially, in the diagram of Professor Huxley, and in my second figure, we have the same elements; and with my other figures Mr. Lankester does not interfere. I do not think, however, that his specimens are so decisive as he implies they are. In his first sketch there is no decided appearance of the central ridge or prolongation, and it appears to me, that there is a much larger portion of the test posterior to the cornua than what is to be discovered in the restoration of Professor Huxley. In his second sketch or specimen, I cannot see any certain evidence of the cornua at all, and therefore, from it also, I cannot gather how the spine or central prolongation of the shield is related to them. Mr. Lankester informs your readers of first-rate specimens having been in the museums and in private collections for some years. Perhaps some of these may throw light on this point, and on other points connected with Pteraspis.

Meantime, believe me, my dear Sir,
Yours truly,
Craig, Dec. 8. Hugh Mitchell.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society.—*November* 19*th*.—"On the Cambrian and Huronian Formations, with remarks on the Laurentian." By J. J. Bigsby, M.D. The author came to the conclusion that the Cambrian and the Huronian are distinct formations, and the latter is very much the older.

December 3*rd*, 1862.—1. "Description of the Remains of a new Enaliosaurian (*Eosaurus Acadianus*), from the Coal Formation of Nova Scotia." By O. C. Marsh, Esq., M.A. Communicated by Sir C. Lyell, V.P.G.S.

2. "Description of Anthracosaurus, a new genus of Carboniferous Labyrinthodonts." By Professor T. H. Huxley, F.R.S., F.G.S.

Anthracosaurus is distinguished from all other known Labyrinthodonts by the quadrate form and oblique position of the orbits, by the existence of elongated supratemporal foramina, and by the comparatively small number and large size of the teeth. The skull exhibited had an extreme length of 15 inches, and an extreme width of 12 inches. There are about 30 maxillary, 2 vomerine, and 10 palatine teeth, which are ridged, and become flattened and two-edged towards their apices. The vomerine, palatine, and some of the anterior maxillary teeth are between 2 and 3 inches long, and from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in diameter at the base. The species exhibited was named *A. Russelli*, after its discoverer. Probably its entire skeleton had a length of not less than 6 feet.

3. "On the thickness of the Pampean Formation near Buenos Ayres." By Charles Darwin, Esq., M.A., F.R.S., F.G.S.

Some sections of Artesian wells sunk in this formation showed its entire thickness near Buenos Ayres to be about 210 feet. It was stated to rest upon various marine beds upwards of 100 feet thick, containing *Ostrea Patagonica*, *Ostrea Alvarezii*, *Pecten Paranensis*, etc. These reposed upon red calcareous clay, which was bored through to a depth of 213 feet more, contained no fossils, and is of unknown age.

4. "Geological Notes on the Locality in Siberia where Fossil Fishes and Estheriæ were found by Dr. Middendorf." By C. E. Austin, Esq., C.E., F.G.S.

5. "Note on *Estheria Middendorfii*." By Professor T. Rupert Jones, F.G.S.

Two ancient stone axes from Trinidad, and one from Santa Cruz, were exhibited by J. Lamont, Esq., F.G.S.

December 17*th*.—1. "On the Skiddaw Slate Series." By Professor R. Harkness; with a note on the Graptolites, by Mr. J. W. Salter. Some general sections through the Skiddaw Slates were described in detail, and the localities in which fossils had been previously found by Professor Sedgwick were especially noticed. The author stated that he had discovered several species of Graptolites new to the Skiddaw Slates in certain flaggy beds almost devoid of cleavage, which occur at intervals in the lower portion of the series, in several localities. Professor Harkness showed that these rocks were much more fossiliferous than had hitherto been supposed; and that the evidence of the fossils, as interpreted by Mr. Salter, clearly proved them to be of the same age as the Lower Llandeilo rocks of Wales and the Quebec Group of Canada. The thickness of the Skiddaw Slates was estimated at 7000 feet, and the total thickness from the base of the Skiddaw Slates to the Coniston limestone at 14,000 feet. Besides several species of well-known Graptolites that are also found in the Lower Llandeilo rocks and in the Quebec Group (Taconic System), Mr. Salter has been enabled to identify *Phyllograpsus angustifolium*, Hall, *Tetragrapsus bryonoides*, Hall, and another species of that genus, *Dichograpsus Sedgwicki*, n. sp., *Didymograpsus caduceus*, and some others. He has given the name of *Caryocaris Wrightii* to a Crustacean discovered in these rocks by Mr. Wright. Mr. Salter considers the Skiddaw Slates to be of the same age as the Quebec Group, the graptolitiferous rocks of Melbourne, and the Tremadoc Slates of Wales.

2. "On Fossil *Estheriæ*, and their Distribution." By Professor T. Rupert Jones. The author pointed out the chief characters of the fourteen species of *Estheriæ* obtained, from several geological formations; and stated that they belong mainly to the passage-beds, and he believed chiefly to fresh and brackish waters. He also compared the distribution of the twenty-two recent species with that of the fossil *Estheriæ*.

3. "On the Flora of the Devonian Period in North-Eastern America." By Dr. J. W. Dawson. Dr. Dawson enumerated in this Appendix some additional species of plants lately obtained from Perry, by Mr. Brown, of that place. He also stated that recent observations have shown that the beds spoken of in his paper as belonging to the Cattskill Group of New York, really represent the Chemung Group of that State, according to Professor J. Hall.

Royal Society.—*November* 20*th*.—One of the largest meetings of the Royal Society we remember to have seen. The attraction was Professor Owen's paper on the remarkable fossil feathered animal which has lately been added to the national collection—the *Archæopteryx macrurus*. In his opening remarks Professor Owen detailed the circumstances attending the discovery of the first evidence of the class Birds in the Oxfordian strata, being the impression of a feather, which was described by Hermann von Meyer, who established for it the genus *Archæopteryx*. This name was retained for the present feathered animal. On November 9, 1861, Andreas Wagner communicated to the Mathematical and Physical Academy of Munich the account of the discovery of an animal with divergent fans of feathers, with which he had become acquainted, on the authority of

M. Witte. Wagner termed this animal Griphosaurus, and, unfortunately, soon after died. Professor Owen communicated with the owner, M. Häberlein, of Pappenheim, whose collection Mr. Waterhouse was deputed to inspect, and ultimately to purchase. The ventral aspect of the specimen was exposed, the furculum marking the fore part of the trunk. It was 1 foot 8½ inches in length, and measured across, from the apex of the right so the left wing, 1 foot 4 inches. Near the anterior border of the imprestions of the wings the stone was broken. The head may have been within this broken part. The ischium, showing the acetabulum, twenty caudal vertebræ, several ribs, the left scapula, proximal part of the left humerus, distal part of ditto, left radius, ulna, and carpals, right humerus, radius, and ulna, two right metacarpals, and two ungual phalanges, right femur, right tibia, left femur, left tibia, were preserved, as well as impressions of the quill feathers, and of down on the body; one clawbone belonging to the right digit of the wing was present, of which bone counterpart impressions exist. The vanes, and even the shafts of the feathers, can be distinctly seen by the naked eye. The furculum, pelvis, and bones of the tail are in their natural positions. The left scapula is displaced backwards: the left humerus outwards and a little forwards, as well as the antibrachium. The wing feathers diverge one inch in front of the carpus. The right humerus extends backwards, and the two metacarpals or proximal phalangeals are dislocated inwards. Fourteen long quill-feathers diverge on each side of the metacarpal and phalangeal bones; the tibia extends outwards. The foot is contracted; the left femur is turned outwards. The feathers decrease in length from six inches to one inch; the anterior series of barbs are longest and obtusely rounded. The area covered by the diverging quills of the left wing is 14 inches; by the right, 11. The three posterior primaries are dislocated backwards; one primary is exquisitely preserved. The impressions of tail feathers number twenty, and succeed each other; the principal correspond in number on each side with the tail vertebræ. The length of the anterior tail feathers is 1 inch, at the end 5 inches; the tail is 11 inches in length, and 3½ in breadth, being obtusely truncated at the end. The wings have a general resemblance to those of the gallinaceous, or round-winged birds. The scapula resembles that of a bird, and was compared with a structure in *Pterodactylus Suevicus*, which was about the same size as Archæopteryx. The curved clavicle was 2 inches long. The scapula was 2 inches broad at the apex, the arch being open and round, not contracted as in Gallinaceæ. No Pterodactyle had a furculum. The humerus, 2 inches 10 lines in length, is sigmoidally flexed as in birds; it was 6 lines in breadth, and in contour most like that of the Corvidæ. The humerus of the Archæopteryx closely resembles the form in many birds, as the penguin, the touraco, etc. The Pterodactyle's radius and ulna were equal in thickness; not so in Archæopteryx. A single carpal bone is shown on the left side; on the right a mass of spar occupies its place; but it is a doubtful indication. The form of the metacarpals agrees with those of birds; but if they be proximal phalanges they differ, being more equal in length and thickness. There is the impression of a slender bone 11 lines long, like the basal part of an ungual phalanx: in advance, a bone supporting the penultimate phalanx is seen in both slabs, being in appearance like the claw phalanx of raptorial birds. The hand, besides supporting the remiges of the wing, probably supported a digit with a small though pointed claw. The structure of the hand otherwise agreed with birds, and similar claws or spurs exist in the *Parra jacana*, the *Palamedea*, the spur-winged goose, and the Syrian blackbird. The Archæopteryx differs from all known birds in having two or three digits in the hand. There was no trace of the fifth digit of the winged reptile. Of the pelvis, a bone on the left side was preserved, bearing a resemblance to the iliac bone of a bird, and with a sinuous border; its exposed surface was smooth and polished, and 7 lines broad. The antero-interior surface of the ilium and the coalesced ischium terminate abruptly and obtusely, as in a young bird. The ischium, behind the acetabulum, shows a vacuity between itself and the pubis, the obturator foramen being as large as in birds. In the Pterodactyle the ilium is shorter, the ischium being subtriangular, joining with the ilium. The sacrum was a confused mass of vertebræ, in which six or seven short transverse processes can be seen. The conditions under which the skeleton was found reminded Professor Owen of the carcass of a gull, which, after having been a prey to some carnivore, which had removed all the soft parts, and perhaps the head, had left nothing but the bony legs, and the indigestible quill-feathers. The tarso-metatarsal, at its distal end, exhibited a trifid, trochlear, articular surface, supporting three toes. The shaft of the femur was long and thin, while a procnemial ridge was present on the tibia. The size of the procnemial ridge is variable in birds; in Archæopteryx it was as large as in *Falco trivirgatus* and in most Volitores. The thigh was longer than in the majority of birds. The proportions of the toes accord with the insessorial, and not with the scansorial type of foot. Few of the bones are in a condition to permit minute comparison of their texture. The osseous remains having been exposed to a disintegrating action by which the phosphate had been converted into carbonate of lime, and in the interior of the bones crystallized spar has been deposited. Each vertebra of the tail supports a pair of plumes. The fossil differed from all known existing birds in having a tail composed of twenty vertebræ. But the tail is essentially a variable character; there are long-tailed bats and short-tailed bats, long-tailed rodents and short-tailed rodents, long-tailed Pterodactyles and short-tailed Pterodactyles. It is now manifest that there existed, at the period of the deposition of the Oxfordian strata, a bird exhibiting the persistent embryonal or generalized character of the tail, as opposed to the specialized condition of the tails of existing birds, in which the terminal vertebræ have coalesced. All embryo birds exhibit the caudals distinct, the greatest number of separate caudals being exemplified by the ostrich. The developmental process undergone by the bird is similar in nature to that through which the fish passes in its transition from the heterocercal stage, through which it usually passes, to the homocercal. The probability of the presence of a single unguiculate digit, as in the wings of Pteropus, would, if demonstrated, exhibit a similar retention of an embryonal and transitory character. The Archæopteryx was unequivocally a bird; and, by the law of correlation, we might infer that it was destitute of fleshy lips, that its feathers were preened by a horny edentulous beak, and that the shape of the breast-bone was such as was possessed by animals capable of flight. The President moved a vote of thanks; and, calling for remarks, the Duke of Argyll hoped that Mr. Gould would offer some opinion on the fossil. Mr. Gould, F.R.S., considered that the remains indicated a terrestrial form of bird, with wing feathers not adapted for flight, as in the Apteryx, or in the black rail of New Zealand. Had the hind foot alone been shown to any ornithologist, he would have been entitled to infer that it was a bird—a fact which Mr. Gould had doubted up to the previous day, but which he now felt constrained to admit. Dr. Carpenter, F.R.S., coincided in Professor Owen's remarks respecting the more generalized vertebrate type of the specimen, and remarked on the futility of negative evidence in geological discussion. Professor Owen pointed out that the shape of the pectoral ridge on the humerus indicated a bird which possessed the power to beat its wings down forcibly, and that the shape of the furculum also indicated a bird of flight. The black rail had no furculum. Mr. Gould adhered to his previous opinion.

MANCHESTER PHILOSOPHICAL SOCIETY.—*Dec. 2nd.*—E. W. Binney, F.R.S., the President, said that in a paper published in vol. x. (second series) of the Society's Memoirs, "On the Drift Deposits found near Blackpool," he had stated, in a note at page 122, that since the paper was written, Mr. J. F. Bateman, C.E., F.G.S., had informed him that in making the Hollingworth reservoir, near Mottram-in-Longdendale, he had met with the common cockspur shell (*Turritella terebra*) in considerable abundance. During the past summer he had visited the locality alluded to by Mr. Bateman, in company with Mr. Prestwich, F.R.S. After going up to the uppermost part of the reservoir, which is one of those belonging to the corporation of the City of Manchester, to the point where the goit conveys the water on the east side of the valley, we saw a deposit of brown sandy clay, or till, which had been cut through to the depth of between three and four feet for the purpose of forming the goit. This deposit contained small granite and greenstone pebbles, some rounded, and others angular. In it he found a considerable number of shells, some quite entire and others in fragments. He procured and showed to the meeting specimens of *Turritella terebra*, *Fusus Bamfius*, *Purpura lapillus*, two specimens of *Tellina*, and *Cardium edule.* The city engineer, Mr. J. G. Lynde, F.G.S., had given him the exact height of the spot where the fossils were found at as 568 feet above the level of the Irish Sea.

Shells, identical with recent sea-shells, have been found at much greater elevations on the mountains of North Wales, but very few so far inland; for the locality where the specimens were met with is full fifty miles in a straight line from the Irish Sea, and a greater distance if the watercourses of the Etherow and Mersey are followed. Mr. John Taylor has found recent marine shells in the sands at Bredbury and Hyde, which he has described in the Transactions of the Manchester Geological Society; and Mr. Prestwich informed him that he has found similar fossils on the Buxton Road, about three miles from Macclesfield, but the specimens herein described are the first that have been noticed in the deep valleys running up into the sides of the Pennine chain.

He further stated that he had found a large mass of greenstone, evidently a travelled rock of the Drift period, at the extreme end of one of the tributary valleys of the Tame, in Saddleworth, as high up as New Year's Bridge, near Denshaw Vale. All these facts proved the former presence of the sea (in some cases containing inhabitants similar to those found on our present coasts) high up on the sides of the Cheshire, Yorkshire, and Derbyshire hills at a recent period, geologically speaking, and show that many of our deep valleys have not been formed by the streams of water now traversing them, but are chiefly due to the more powerful action of the waters of the ocean, most probably assisted by ice.

NOTES AND QUERIES.

OBITUARY.—On the 19th of December, one of the oldest and the most famous anatomists and ethnologists of England departed this life. We allude to the venerable Dr. Robert Knox, Hon. F.E.S., the friend of Cuvier and Geoffroy St. Hilaire, and the Honorary Curator of the Museum of the Ethnological Society of London. Our space will not permit us to do more than record the fact, with the tribute of our admiration for the talents and labours of the deceased, and the expression of our consciousness that a school of scientific thought was founded by him which will survive when his faults and failings shall have been all forgotten.

DEEP GOLD DIGGINGS OF MELBOURNE.—As the opinions expressed by Sir Roderick Murchison ('Siluria,' 3rd edit. p. 488), that wherever the veinstones in the solid rock have not been ground down by denudation, and remain as testimonials of the original seat of the gold, the portions which have as yet proved to be the richest are those which are at or nearest the surface, have been recently seemingly impugned by the accounts which have reached us respecting the deep quartz gold mines in Australia,—the following note, by Professor M'Coy, of Melbourne, gives an important confirmation of the correctness of Sir Roderick's original conclusion. In a private letter, writing of the deep gold diggings of Melbourne, he makes these comments on them :—" Sir R. Murchison's theory, which I have always upheld, of the ratio of gold in the quartz veins diminishing with the depth, is every day getting more support. You must be cautioned that so many ounces of gold, said to have been crushed from so many tons of quartz from deep mines, really means, that perhaps 1000 tons may have been mined, and out of it 100 tons picked as rich enough to be sent to the mills ; so that the richness of the deep quartz is very different from what it would appear without this correction, which you must always ask after before you give up your correct position, yielding to the logic of supposed facts which are really capable of explanation."

CANADIAN PETROLEUM.—The 'Canadian Journal of Art' asserts that the Canadian petroleum is not derived from coal, nor is it of recent origin. It says : " Petroleum was formed long before the coal, and is the result of an infinite number of oil-yielding animals which swarmed in the seas of the Devonian period long anterior to the coal. The decomposition of marine plants may have given some oil to the rocks of Canada and the United States which are saturated with this curious substance. The shale beds of Collingwood furnish an answer to those who object to the infinite number of animals it would require to produce the oil locked up in the earth. These shale beds are composed altogether of the remains of trilobites ; they extend from Lake Huron to Lake Ontario, and from west and east of these lakes. The oil-bearing rocks of Canada were once a vast coral reef, extending from the Gulf of Mexico to Lake Superior."

IRON FORMED BY ANIMALCULES.—In the 'Journal de l'Instruction Publique,' M. Oscar de Watterville states that in the lakes of Sweden there are vast layers or banks of iron exclusively built up by animalcules. The iron thus found is called " lake ore," and is distinguished according to its form, into " gunpowder," " pearl," " money," or " cake " ore. These iron banks are often from 10 to 200 yards in length, 5 to 10 broad, and from 9 inches to a yard in thickness. In winter, the Swedish peasant, who has but little to do in that season, makes a hole in the ice of a lake, and with a long pole probes the bottom until he has found an iron bank ; an iron sieve is then let down, and with a sort of ladle conveniently fashioned for the purpose, the loose ore is shovelled into the sieve, which is then hoisted up again. The ore thus extracted is of course mixed up with sand and other extraneous matters, which is got rid of by washing in a cradle like that used by gold diggers. A man can turn out a ton of ore per day by this process."

REVIEWS.

Carte Agronomique des Environs de Paris. By M. Delesse.

A "Carte Agronomique des Environs de Paris" has been published by M. Delesse. We need not say that a map by the able engineer of mines and professor of geology at the Ecole Normale is a good one. M. Delesse is one of those men who never do anything otherwise than well. Although the vegetable soil is only of slight thickness its importance is very great, and many *savants*, at the head of whom is M. De Caumont, have attempted to represent its variable composition by special maps called "Cartes Agronomiques." M. Delesse has lately laid before the French Society of Agriculture one of these maps for the environs of Paris. Such labours are not without considerable difficulties in their execution. The soils require detailed and minute examinations, and their characters sometimes change completely in contiguous districts; on the other hand, the elements remain nearly always the same, and vary more in their proportions than in their nature. This uniformity of materials causes the greatest difficulty in denoting the mineralogical composition, changing sometimes in an insensible and gradual manner; and thus, whilst, on the one hand, the different vegetable soils are not separated by exact limits, on the other, the mineralogical composition is very complex. It is hence scarcely possible to figure them by tints, as one would do a geological rock. The notation adopted by M. Delesse is in this manner:—The soil richest in humus is indicated by fine blue diagonal hatching; the sand, gravel, and stony débris forming the residue of lævigation, by red parallel signs; and the clay, marl, humus, and particles strained off in lævigation, by vertical blue signs, and so on. To render sensible to the eye the proportions of the principal substances over the extent of the maps, these signs have been disposed methodically in small squares.

The details given by M. Delesse on the conditions and manner of occurrence, and quantities in different places, are highly instructive. The soils he finds always contain clay, sand, and ordinarily stony débris. The humus is also found in a constant manner, and is essentially characteristic of a vegetable soil. It is especially very abundant in valleys and in all depressions of the soil, even when these cavities are seated on tops and sides of hills. Particularly it is concentrated in the bottom of damp valleys, and where the soil is saturated with water.

Limestone is found in variable proportions, but its disposition is subject to definite laws. It is wanting generally on the heights. It is wanting also in the soils on the terraces bordering the Seine and the Marne. It is absent even at the head of the valley of the Bièvre. The calcareous region includes the thalwegs, the depressions on the plateaux, the flanks of the hills, and particularly the bottom of the valleys.

The proportion of carbonic acid in the vegetable soil is, on the plateaux, *nil*, or reduced to mere traces. It is only when a very thick diluvial deposit reposes on a calcareous subsoil that it can attain to a few hundredths. On descending a hillside, the carbonic acid is very scanty at the upper part, but augments progressively with the declivity, offering at times various alternations. The same occurs in descending a valley; in that of the Bièvre, for example, carbonic acid is wanting in all the elevated portion; it then augments as the valley descends until it finally attains 10 per cent. On the shores of the Seine and the Marne, it sometimes exceeds 25 per cent. The residue of lævigation is essentially formed of sands coming from the Fontainebleau beds, from flint, gravel, and the limestones of the Beauce and the Brie. Calcareous débris is rare; and grains of iron and feldspar still more so. On the plateaux the residue of lævigation is very variable, even in the vegetable soil covering the same rocks. Thus on the plateaux above Gurches and Mendon, it rises to 70 per cent.: but more to the south, towards Saclay, it is reduced to a few hundredths. In the valleys, also, it varies, not only in the different valleys but also in the longitudinal and in transverse directions. The proportion of fine sand is also very notable in the bottom of the valleys; on the banks of the Seine and the Marne it varies from a few hundredths. Clay is found also in all the soils round Paris, sometimes pure, sometimes in the state of marl associated with lime. The soils which cover the plateaux formed by the lacustrine rock of the Beauce and the Brie, are particularly rich in clay. At Crenilly and Villejuif the proportion of clay is above 50, and it may sometimes reach to 90 per cent. But the clay is especially concentrated in the bottoms of the valleys, whether they be dry or wet.

The examination of the constituent mineral substances shows that the soil comes in part from the subjacent rocks, and partly from the rocks in the neighbourhood; and that it must not be always regarded as a disaggregation *in situ*, for we often find that in limestone rock the vegetable soil contains not a trace of calcareous matter; and, *vice versâ*, a highly calcareous soil over a clay base. The vegetable soil M. Delesse considers as decidedly belonging to the "terrain de transport," or drift, as shown by the sand, gravel, and innumerable rolled fragments it contains.

The practical value of M. Delesse's map is that, in indicating the mineralogical composition of the soil in the Paris district, it is easy to see what lands should be marled, and which should be drained, and to what extent, and with what materials, manures and extraneous substances should be economically employed in agricultural operations.

Ueber Thierfährten und Crustaceenreste in der unteren Dyas, oder dem unteren Rothliegenden, der Gegend von Hohen Elbe. Von Dr. H. B. Geinitz.

On Animal Tracks and Crustacean Remains in the Lower Dyas, or in the Lower Permian Sandstones of the Strata of the Higher Elbe. By Dr. H. B. Geinitz. (Extracted from the 'Isis' of Dresden.) 1862.

Dr. Geinitz, undismayed by the severe criticism he received at the hands of Sir Roderick Murchison, ('Geologist,' January, 1861,) proceeds systematically to describe the fossils which are found in his so-called Dyas strata of Central Germany. Mrs. Josephine Kablik, a lady who cultivates natural science in that neighbourhood, has discovered several interesting fossils, which are described and figured in the work before us.

The *Dalmanites (?) Kablikæ*, Geinitz, is figured. It is a small Trilobite, which Geinitz considers may belong to the Silurian genus Dalmanites. Dr. Geinitz also figures a remarkable Phyllopod crustacean, somewhat resembling the *Branchipus stagnalis* of Linnæus, which he considers to be a new genus, Kablikia. The *Kablikia Dyadica*, Geinitz, is found in the coal-slates of the Lower Dyas, near Nieder-Stepanitz, on the Higher Elbe. The original specimen is in the Dresden Museum.

The limestone slates of the Lower Dyas have afforded evidence of impressions, considered by Dr. Geinitz to be those of a Crustacean, the specimens of which are also in the Dresden Museum. They are somewhat similar to those which Hall has figured in the 'Palæontology of New York,' considering it doubtful whether they belonged to Crustacea or Fishes.

The paper is illustrated with two well-executed lithographic plates.

Observations on the Terms "Permeen." "Permian," and "Dyas." By Jules Marcou. Boston. 1862.

These "Observations" have been reprinted by M. Jules Marcou, from the Proceedings of the Boston Society of Natural History, in which he refers directly to the article by Sir Roderick Murchison, printed in the last year's January number of this magazine, and gives a list of dates in respect to the priority of the term "Permian."

M. Marcou also refers to his own memoir, "Dyas and Trias," in the 'Archives de la Bibliothèque Universelle de Genève,' 1859, as treating the two questions entirely distinct. Since the first publication of M. Marcou's paper, M. Ludwig, one of the associates of Dr. Geinitz, has been to Russia, and has published the results of his researches, under the title 'Geogenische und geognostische Studien auf einer Reise durch Russland und den Ural.' We have not yet seen this work, and therefore cannot say of our own knowledge whether it does or does not bear out M. Marcou's statement that it gives ample facts and sections to show "the inapplicability of the term 'Permian' to the Dyas of Saxony; a term which indeed would not have been for a moment maintained if its typical localities were in a more accessible part of the world."

M. Marcou next considers the necessity of the union of Dyas and Trias into a great geological period—the New Red Sandstone. This period he considers in time and space to be of the same importance as the Grauwacke or Palæozoic, Carboniferous, Secondary, Tertiary, and Recent periods. He has never admitted the union of the New Red Sandstone with the Carboniferous or the Secondary.

Etude sur l'Etage Kimméridien dans les Environs de Montbéliard. By Dr. Ch. Contejean. Leipzig: J. Rothschild. 1860.

Acting on the recognized principle of marking geological periods by particular palæontological faunæ, Dr. Contejean has set about to determine the boundaries and members of the Kimmeridian formation of Montbéliard, and in the Jura, France, and England. To the want of due regard to palæontological evidences, and the too great importance attached to petrographical facies, Dr. Contejean attributes the great number of purely artificial divisions—the limitation of the systematizing of the beds being thus restricted to the mere differences of mineral composition, without due regard to palæontological horizons. In the Jura, the massive "Astarte, Pterocera, and Virgula marls" are ordinarily taken as the base of the Kimmeridge group; upon these are superimposed directly thick intermediate limestones, often sterile or but slightly fossiliferous. These divisions may be strictly conformable to subpelagic regions, where the marly beds alone received the organic débris. "But," well asks Dr. Contejean, "are these good divisions in themselves, and can they be applied more generally?" This question he answers in the negative, and cites the very rich fossiliferous localities of Montbéliard and Ponentruy as evidence. In those regions, formerly littoral, the limestone strata which separate the marls have received the relics of faunas hitherto not appreciated, but which are of equal value with those of the marls, and consequently entitled to rank as independent sub-groups. Moreover, the faunas of certain marl horizons are in no wise different from those of the limestones in their respective vicinities; and thus the natural limits of the divisions are not always restricted either to the base or to the surface of a marl-bed; whilst some limestones belong to two, or even three, different divisions, and therefore if there exist three chief divisions in the Kimméridien formation, the limits of these groups are very different from those which have been assigned to them.

These are the opinions Dr. Contejean has striven to work out in the book before us, and to this end he first describes the geographical range of the Kimmeridge beds, through Damvant, Abbévillers, Audincourt, Montbéliard, and Belfort, in a north-westerly direction; then through the Allan Valley to the district of Ponentruy; and next, south-westwards, to Longvelle and l'Ile-sur-le-Doubs. He then describes the subdivisions, with their mineral characters and their characteristic fossils. These subdivisions are:—(1) *Calcaire à Astartes;* (2) *Calcaire à Natices;* (3) *Marnes à Astartes;* (4) *Calcaires à Terebratules;* (5) *Calcaire à Cardium;* (6) *Calcaires et Marnes à Ptérocères;* (7) *Calcaire à Corbis;* (8) *Calcaires à Mactres;* (9) *Calcaires et Marnes à Virgules;* (10) *Calcaire à Diceras.*

A section of his book is now devoted to detailed lists of the respective faunas of each of these subdivisions, and to comments upon them. After a summary of the facts thus brought forward, he tabulates his results in the following manner:—

Étage Kimméridien.

IV. Groupe Nérinéen .	Subdivisions to be made out.
III. Groupe Virgulien .	10. s. gr. *Calcaire à Diceras.*
	9. *Calcaires et Marnes à Virgules.*
	8. *Calcaire à Mactres.*
	7. *Calcaire à Corbis.*
II. Groupe Ptérocérien	6. *Calcaires et Marnes à Ptérocéras.*
	5. *Calcaire à Cardium.*
	4. *Calcaire à Terebratules.*
I. Groupe Astartien .	3. *Marnes à Astartes.*
	2. *Calcaire à Natices.*
	1. *Calcaire à Astartes.*

The last question then remains—what are the limits of the Kimméridien as thus defined? These Dr. Contejean asserts are exactly indicated. The Kimmeridge division terminates the Jurassic marine series, and is naturally arrested by the Purbeck beds, which most geologists have considered cretaceous, but which the author considers M. Coquand has rightly associated with the Jurassic formation. The inferior limits he sets forth as equally easy to establish, the Kimmeridge division commencing where the mass of fossil corals ends, or immediately above the Diceras beds of the Coralline Oolite.

The fourth section of his work Dr. Contejean devotes to the "Parallelism of the Formation," and notices the characters presented in the Mediterranean basin, Straits of Dijon, Anglo-Parisian basin, and the Pyrenean basin. This is followed by a fifth portion, with geological sections and a general list of the fossils of the whole formation. The remainder of the book, amounting to a hundred pages, is taken up with detailed descriptions of new or critical species of shells, which are illustrated by twenty-four admirable lithographed plates, very carefully and accurately drawn. The book is moreover illustrated by three plates of sections and stratigraphical diagrams of the ranges of the various groups of fossils.

We have, in former reviews, had occasion to speak well of the geological works published by M. Rothschild, but of none we have yet noticed could we desire to speak in higher terms of praise than of Dr. Contejean's admirable monograph before us.

THE GEOLOGIST.

FEBRUARY 1863.

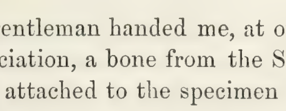
TURTLES IN THE STONESFIELD SLATE.

By the Editor.

Some time since, a gentleman handed me, at one of the meetings of the Geologists' Association, a bone from the Stonesfield slate. Unfortunately the label attached to the specimen has been accidentally lost, and consequently I can neither give due credit to its owner for his find nor return the specimen to him as I would wish to do, as his name and address are both thus unknown to me.

The nature of the specimen was very evident, at the first glance, to any practised palæontologist. It is a bone that is peculiarly characteristic of a peculiar class of reptiles which, at the present day, comprises the tortoises, terrapins, and turtles. In short, it is the coracoid bone of some member of the family Chelonia.

Our evidences of this order of reptiles, in strata of Mesozoic age, are few and far between; but Chelonian remains are rare in the Secondary beds, chiefly by reason that many of our most productive localities are neglected to be well worked.



Chelys (?) *Blakii* (n. s.), from the Stonesfield slate.

The impressions, probably referable to Chelonian animals, which we have in the Triassic sandstones of Corncockle Muir, are at least doubtful, and we shall not insist upon them as evidences here. In the Upper Oolitic slates of Cirin, where a lithographic stone somewhat resembling that of Solenhofen is quarried, there have been discovered remains of emys-like turtles named *Achelonia* and *Hydropelta.* The *Chelone planiceps* has been obtained from the Portland beds, and the curiously complicated and to a certain extent "embryonal" genera *Tretosternon* and *Pleurosternon* from the Purbeck. In the cretaceous beds we have discovered true marine turtles (*Chelone Camperi*, *Chelone Benstedii*, and *Chelone pulchriceps*); a terrapin (*Protemys*) has come from the Kentish Rag of Maidstone (Lower Greensand), whilst many species of small turtle (*Chelone*) are mingled with the phosphatic nodules of the Cambridge Upper Greensand.

This coracoid bone I recently handed to my friend Mr. Carter Blake for further and more complete examination, and he has kindly favoured me with the following note:—

"This specimen consists of the crushed right coracoid bone, viewed from above, of a Chelonian reptile. I have compared it with the homologous bone in the varied kinds of *Chelonia*, and find a form which resembles it very nearly in the Matamata (*Chelys matamata*, Gray). The family of turtles to which the matamata belongs is to be found in ponds and rivers in warm climates. Dr. Gray tells us that they eat flesh, feed only in the water, and when they swim the whole shell is submerged. As however it is believed that the *Trigonia*-bearing Stonesfield slate was a sea-deposit, and as there is no doubt whatever that this fossil is really from that bed, there is some degree of antecedent improbability against its representing a freshwater form. Furthermore, taking into account the manifold variations of form which the coracoid bone exhibits in the Chelonia, there is really no reason, morphological or teleological, why a marine species of turtle may not have existed in the Oolitic sea with a coracoid bone so far differing in shape from that of the existing marine turtles (*Chelone*) as to resemble the homologous bone in the matamata. The turtle of the Oolite co-existed with the *Phascolotherium* and the *Trigonia*, much in the same way as the allied genera of turtles, *Chelymys* and *Chelodina*, co-exist on the same continent with the Australian marsupials, whose remains may be perchance washed into the sea where *Trigonia* still survives.

"Upon one little fractured bone, however, we must not draw any positive conclusions. No doubt, when the Stonesfield slate shall have been more thoroughly explored, further evidences will be afforded. In the meanwhile, without prejudging the question whether the fossil before us be referable to a freshwater or a marine form, I incline slightly to the former opinion."

Remains of scutes of Chelonian reptiles have, since this specimen has been in our hands, been offered for purchase to the officers of the British Museum; but whether they belong to the same species we are not in a position at present to hazard an opinion.

We may add that M. Hugi has discovered in the Kimmeridian beds of Soleure bones of *Emys*, associated with marine mollusca. Pictet suggests that their remains may have been transported by freshwater currents.

As a provisional arrangement, we would prefer to include our specimen in the genus *Chelys*, giving it a characterizing specific name in honour of our friend who has so obligingly worked out its relationship to the other reptiles of the interesting family to which it belongs.

ON THE OCCURRENCE OF GLYPTOLEPIS IN THE SANDSTONE OF DURA DEN.

By the Rev. Hugh Mitchell, M.A.

In his admirable essay on the Devonian Fishes, in the Tenth Decade of the Geological Survey, Professor Huxley has clearly indicated and described the differences and the resemblances of the genera Holoptychius and Glyptolepis. In the interesting work of the Rev. Dr. Anderson on 'Dura Den,' in which its exquisitely-preserved fossils are described, no mention is made of Glyptolepis. In the November part of the 'Journal of the Geological Society of London,' Mr. Powrie has called attention to the occurrence of Glyptolepis in slabs recently disinterred, for the St. Andrew's Museum, from Dura Den. Through the kindness of Dr. Anderson, a slab was presented to the Montrose Museum in 1859; and it is now apparent from it that Glyptolepis is not of rare occurrence at Dura Den, and that either this genus has been passed over altogether, or confounded with Holoptychius. The fishes in the Montrose Museum are smaller, and do not in all points correspond with those described by Mr. Powrie, but we think they emphatically demonstrate that the *Holoptychius Flemingii* must now be denominated Glyptolepis.

On the slab in the Montrose Museum there is one fine specimen of Holoptychius and six specimens of Glyptolepis, not regarding fragmentary portions of fishes. At the first glance there is a resemblance in size, in general aspect, and outline, among the fishes. Their average length is about nine inches, and their breadth at the thickest part of the body nearly three inches. But, on looking more closely, we at once discover the characteristic differences of the genera. The scales of Glyptolepis are far more numerous—apparently as four to one—and are set more closely together and with a deeper imbrication than those of Holoptychius. There is a considerable variety, although nothing of the kind can exceed the beauty of the sculpture of the scales as taken from different parts of the body. The scale of Holoptychius (*all wrinkle*) may be represented by the accompanying figure, Pl. III., fig. 4. It is divided into two portions: the anterior portion, which is smooth, and is covered by the imbrication: and the posterior portion, often deeply sculptured with anastomosing ridges. The scale of Glyptolepis (*carved scale*) may be represented by the accompanying figure, Pl. III., fig. 5, although in this genus there is a greater variety in the sculpturing. It is divided, also, into two portions: the anterior portion, which is covered with a beautiful arrangement of small eminences, radiating in concentric circles from the middle of the scale, and becoming very minute as they approach the margin; and the posterior portion, which is covered with ridges, leaving sometimes a smooth edge on the hinder margin.

The cranial bones of both genera are also sculptured, but with a difference. Those of Holoptychius are covered with a confluent tuberculation, whilst those of Glyptolepis present waving longitudinal ridges.

On the Holoptychius one of the dorsal fins is alone shown, presenting, however, stouter rays than the pendulous corresponding fin of the Glyptolepis. Unfortunately, no comparison can be instituted from this specimen respecting the caudal fins of the genera.

The dentition of the Holoptychius is not seen, but Glyptolepis displays several large teeth intercalated amongst a series of small ones. The medial line along the flank is far more deep and marked in Glyptolepis than in Holoptychius.

From the description given by Mr. Powrie of the St. Andrews specimen, we are led to suppose that two species of Glyptolepis occur at Dura Den—the other much larger than the species we have attempted to describe as above. But one thing is certain, the genus is to be found there. The determining of this matter may cast no new light on the position of the sandstone of Dura Den, but at least it will prevent confusion in the description of its palæontology.

NOTE ON STONE "CELTS" FROM CHIRIQUI.

By Charles Carter Blake, Esq.

(*Read before the Ethnological Society, March* 18, 1862.)

Five stone "celts" have been submitted to me, from the collections of antiquarian objects from Chiriquí formed by my friends William Bollaert, Esq., F.R.G.S., Corr. Mem. Univ. Chile, etc., and W. Duprée, M.D., F.R.G.S., of Panamá.

No information has been given to me respecting the locality, condition, or probable age of these "celts." I understand, however, that they were obtained from the same graves in Chiriquí whence have been derived the various objects wrought in gold and moulded in pottery, some of which have been lately described in the United States, and in this country by Mr. Bollaert.

All the celts exhibited the well-known scalpriform sharpening of the larger end, and are sharpened laterally by a succession of blows, producing facets, analogous to those of the chipped flints which have been found at Abbeville,* at the Kjökkenmöddings in Denmark† and in various European localities, and which probably belong to a period antecedent to the known historical era.

Four of the celts, marked B 2, B 3, D 1, and D 2, are composed of the porphyritic stone found in great abundance on the Isthmus of Darien. One only, marked B 1, is hewn more roughly than the others from an indurated clay, and closely resembles some of the European worked flints.

B 1 (measuring $4\frac{4}{10}$ inches) is of a tapering acuminate form, the lateral facets being so deep, and so widely extending across the celt, as to have produced a more or less salient ridge, extending longitudinally along the median line of the celt. The larger end is polished on either side for a small extent up the hatchet. The stone, however, by its porous nature, has not been susceptible of much polish. The smaller end is prolonged to an acute point.

D 2 (measuring $3\frac{3}{10}$ inches). The sculptor's art has in this celt progressed to such an extent as to produce a polished surface, obliterating the facets, and extending over the whole stone, with the exception of the acuminated but unsharpened smaller extremity.

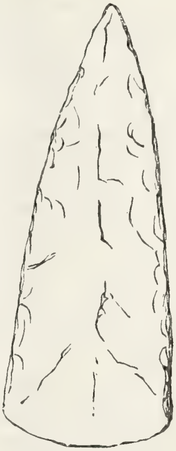


Fig. B 1.

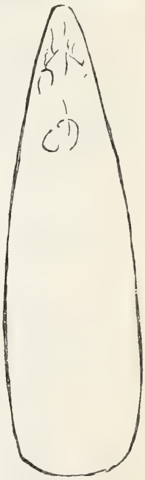


Fig. D 2

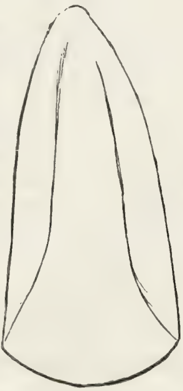


Fig. B 3.

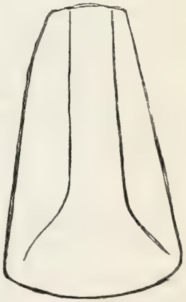


Fig. D 1.

In the three following "celts" the longitudinal diameter is much less than in the two above mentioned.

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* Prestwich, Phil. Trans., 1860. Evans, 'Archæologia,' 1860, 1862.

† Natural Hist. Review, Oct. 1861.

B 3 (measuring 4 inches). The surface of this stone has been polished to a greater extent than in D 2. The smaller end is not only polished, but has its tapering extremity rounded off. Subsequently to the polishing process, the lateral portions have been submitted to the action of some substance which has rubbed and ground off the polished surface, apparently with a view of rendering the sides more acute.

D 1 (measuring $3\frac{4}{10}$ inches). A similar process has been exercised on this specimen, on the lateral portions, whilst along the median line, the ridge, which was so prominent a feature in B 1, has been artificially obliterated. The polished portion extends a small distance up the blade. The acuminated point has been broken away, exhibiting a hexagonal fracture.

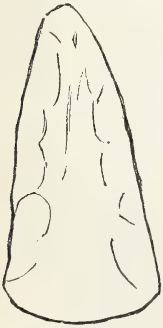
Fig. B 2.

B 2 (measuring $3\frac{2}{10}$ inches). This celt, of a lighter porphyry than the others, presents the facet-shaped arrangement of the lateral portions, which is exhibited to a greater extent in B 1. It is polished at the sharp extremity. The acuminated extremity is obtusely rounded; near it, a deeper facet than the rest is removed, with the probable purpose of rendering more firm its attachment by some ligature to its handle. No such device is found in the four other celts.

The above five celts, therefore, offer each distinctive characters, and probably indicate different fashions and patterns of the sculptor's, or rather cutler's, art in Chiriquí. The specimen B 1, by its rough facets, its slight degree of polish, its general flat appearance, and its comparative simplicity of workmanship, seems to indicate its being the product of a nation not much superior in civilization to the denizens of the Kjökkenmöddings in Denmark. Reasonable ground of doubt may exist as to whether it belongs to the same era as the four porphyritic celts. The nation which produced such works of art as some of the Chiriquí pottery and gold objects, would surely have arrived at a higher degree of perfection in its weapons. It is undoubtedly, also, a finished celt, complete as far as its maker intended it to be—not a mere spoilt model, thrown aside. The absence of proof respecting its actual collocation with the Chiriquí antiquities, would lead me to assign to it a far higher historical remoteness, and render it possibly coeval with the remains of the old short-headed (brachycephalic) mound-builders of Natchez, whose epoch in time antiquarian archæology in North America has as yet been unable to ascertain.

The four porphyritic celts have no such distinctive characters. They might be the work of the earliest inhabitants of Chiriquí, or the product of the idle Indian of the present year.

A careful examination of the various types of celts, as denoting distinctness of race, has led me to the conviction that the Chiriquí celts are entirely *sui generis*. They differ from the more heavy cutlery of the mound-building Natchez in their less weight and their more acuminated form. A sketch from Squier's 'Monuments of the Mississippi Valley' indicates the size of the celts of the short-headed mound-builders. It was six by four inches, and weighed about two pounds. It is undoubtedly a finished celt. Upon a comparison of the Chiriquí celts with the obsidian knives from Mexico, no resemblance exists. Their closest analogy is with the hatchets from the stone mounds of Denmark. Dr. Troyon has observed that "man, placed under analogous circumstances, acts in an analogous manner, irrespective of time or place." We thus have analogous flints from wholly distinct parts of the world.* Whether these evidences indicate the once almost universal dispersion, antecedent to the historical epoch of whole nations of men, little elevated above the animals, whose remains have been preserved to us in strata often containing the débris of extinct mammalia, I must leave to this Society to determine. The antiquity of the human race in America, inferred from the existence of so many native traditions of the *rapports* which early man once bore to the extinct animals, is thus rendered more probable by the antiquarian evidences now afforded us.

I cannot close this paper without expressing my sincere regret that no osseous or cranial remains have been afforded us of the aborigines of Chiriquí and Panamá. Such proof can alone conclusively demonstrate the true affinities of nations, or the probable era when they existed. Mere archæological evidence is an uncertain guide.

In conclusion, I beg to remark, that at first sight the mere degree of chipping which a flint might have undergone at human hands might seem a trivial subject of discourse; but when we reflect upon the aphorism of Sir Thomas Browne, that "Time conferreth a dignity upon the most trifling thing that resisteth his power," the study of these carved stones from Chiriquí becomes fraught with considerations of the highest mental value.

REPORT OF A SUCCESSFUL SEARCH FOR FLINT-IMPLEMENTS IN A CAVE CALLED "THE OYLE," NEAR TENBY, SOUTH WALES, IN JUNE AND JULY, 1862.

By Gilbert N. Smith, Rector of Gumfreston.

(*Read at the Cambridge Meeting of the British Association*, 1862.)

This is a cave in the Mountain Limestone, with a wide entrance looking to the north-east at about 70 feet above the level of the valley beneath, up which the tide has recently flowed. The cave extends tortuously for 30 or 40 yards into the axis of a ridge which is a spur of the "Ridgeway," extending from Pembroke to Tenby, composed of the Old Red, the strike of which is east and west.

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* Boucher de Perthes (*Antiquités Celtiques et Antédiluviennes*, 8vo, ii. 232) describes a series of analogous half-polished hatchets, as appertaining to the "transition"

Within, the cave is distinguished by chambers, alternating with narrow passages. The floor is generally not more than three feet deep, at which depth the limestone is met with as at the roof and sides. The entrance being conspicuous, it is often visited from curiosity, but has never before been carefully explored for the definite purpose of discovering works of ancient art. This search was prompted by the recent discoveries in France and at Hoxne, strongly seconded by the fact that above, on the Ridgeway, some six or seven barrows exist, which yielded to the reporter and others a few years since, not only cinerary urns, but also well-shaped flint arrow-heads.

So much by way of introduction.

The Section will be glad to learn that the search in this cave for flint weapons has been successful, and that the number found is seventy-three, including the identical lumps of flint which remained after the chips had been struck off, when from their reduced size they were no longer capable of yielding flakes sufficiently large to answer the destined purpose, whatever that might be.

Some of these specimens are of ordinary flint, but a good many are of a dull-green opaque chert. In size they vary from about four inches in length, downward. In general form they are almost identical with the flakes found at Red Hill. They were disseminated through the soil, but much the most thickly scattered at the mouth of a recess near the entrance, where the fabricator might be supposed to have seated himself to take advantage of the light.

Interspersed also through the soil, which in some places is almost black, were a great many bones; most of them those of ruminants, such as are now domesticated; some of them fish-bones, with the shells of edible mollusks; and some few unmistakably the remains of cave-mammals, such as *Ursus spelæus*, *Equus caballus*, *Hyæna spelæa*, and the teeth of some species of deer. Of this last animal, though apparently of a later age, there is one very fine front prong of an antler, which measures 11 inches, and the circumference 4½ inches at the base, where there are long marks across as if done with some tool. To these works of ancient art and animal remains must be added some very modern articles; one of them the half of a Sheffield penknife, which, however, seemed to have been buried some years.

The conclusions and inferences which the author of this report has come to will be comprehended in replies to the following questions:—1st. What was the use of these flakes? 2. By what race of men were they fabricated? 3. Whence was the material derived?

First, the use of these flint, and chert flakes. The conviction ar-

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period between the pre-historical and the Celtic nations. He describes one of these "celts" as "*une hache à gaîne ou demi-polie. Le tranchant l'est entièrement. La partie destinée à entrer dans la gaîne ne l'est pas.*"

In the British Museum collection of antiquities, an object, termed by Mr. Bollaert a "stone club," is preserved from Cocina, in Peru, near Noria. Mr. Gilbert Brandon has also preserved a "stone hatchet-blade used in the time of the Incas," from Cuzco; whilst amongst the Mexican antiquities presented by Lady Webster, is to be found a "*cincel de los Indios, encontrado en una sepultura,*"—where, is not stated.

rived at from a general view of them scattered upon the table, whether found in "the Oyle," at Red Hill, or elsewhere, is that these chips are the rejected refuse of the workshop. "On this spot," the thoughtful observer is disposed to say, "some weapons or implements were fabricated on some one or more occasions; and while the perfected ones were carried away, these inartistic though somewhat shapely fragments were left on the floor where they fell, and at length became buried, partly by the tramp of animals, and partly by accidents of daily human life." I feel sure of this conclusion, not only because most of the flint chips which we have in collections (as that handful, for instance, in the British Museum, which are said to have come from Arabia) are in reality nothing but primary splinters, which have never received a second perfecting stroke or trimming from the hand, but also from the following argument:—

Assuming these to be mis-shapen chips struck off on the spot, would there not be found among so many one or two perfected specimens of the tools or weapons assigned? This is very probable—almost certain; but not so probable as that some broken specimen of the tools, broken in the process of completion, would occur here and there. And so it proves in this case; for among these seventy-three specimens, there are eight broken pieces which have received much manipulation, and have heads elaborately rounded off, by removing small conchoidal scales. And further, the lumps of flint which have been split up as long as they would yield flakes strengthen the argument; for they, too, are left behind commingled with the rest of the abandoned fragments.

Secondly, by what race of men were these implements fabricated? The reporter, supposing these chips to be ancient, has no hesitation in ascribing them to the same natives of Britain by whom the tumuli on the Ridgeway above were raised, and who buried with their dead the flint arrow-heads found within those mounds. No other supposition obviously needs to be entertained.

But who were this race of men? The world say, "Britons, to be sure; these are British barrows, and those vases on your shelf are British urns that you obtained from them."

Well, let us suppose so for a while. But surely, if such is the case, these descendants of the British who live around "the Oyle" and the barrows here in Wales, and who certainly are in possession of much ancient literature, while the Saxons brought us next to none, would be able to inform us whether their ancestors ever used flint tools or weapons in early days, especially as the records relate to the very first possession of the island by the race of Adam. Led by this thought, I have corresponded with the ablest Welsh archæologists, and have been favoured with full replies; but all deny that their forefathers ever used anything but bronze and iron for war or in the chase, but say that there is a notice or two in their very early documents of the use of flint knives for sacrificial purposes only. This admission, however, proves nothing; for other races of men,—the Jews, for instance,—while they certainly had tools of metal, uniformly employed flint knives in sacrificing animals, and for circumcision. From this absence of all reference to flint or stone weapons in the earliest writings of the Welsh, it seems to follow, either that the writings cannot be depended upon to supply precise information, or that the men who made the flint weapons were of another race, possibly much earlier inhabitants of the island.

Thirdly, whence was the material obtained? There are no flints in the formations and strata of the vicinity,—that is certain. But then they may be picked up any day by a careful search on the shore; and so may granite boulders and worn fragments of igneous rocks.

The chert of these implements is peculiar. It is of a dull, opaque green colour, full of minute grey spots. I do not at present know of any like it in these parts; but one lump, tide-borne to the coast, would have supplied all required for the sixteen fragments of this kind found.

CORRESPONDENCE.

Age of the Blackdown Greensand.

Sir,—The question as to the true position in the Greensand series of the "Whetstone" deposits of Blackdown, in Devonshire, is one which, so long as it remains uncertain, must naturally force itself upon every geologist who either studies or collects the fossils of the Greensand formation; and, therefore, although this question is neither new nor of universal importance, I trust that I may be permitted to refer to it in the present instance.

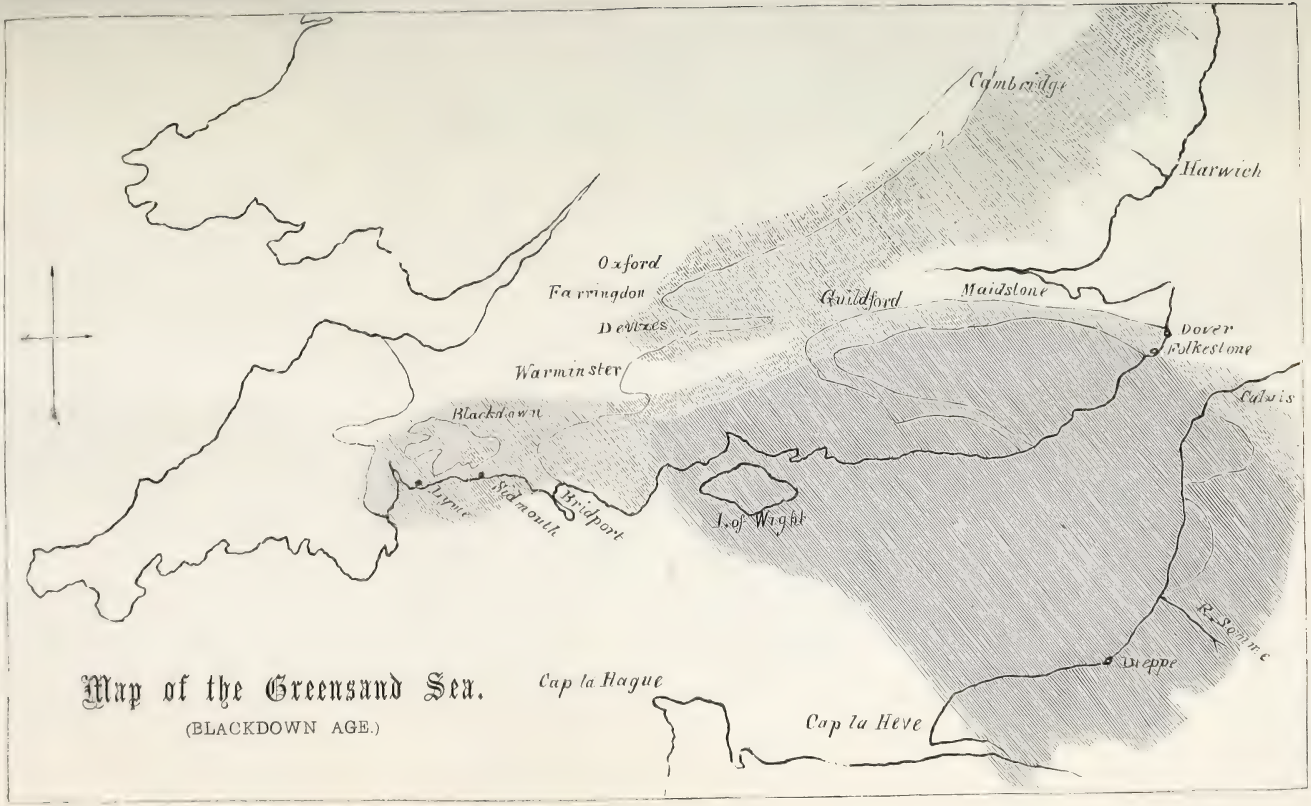
The question is simply this—Are these (Blackdown) deposits equivalent to the Upper Greensand, to the Gault, or to a portion of the Lower Greensand? or do they represent the whole of these in an exceptional form?

In parts of Kent or Surrey, where the Lower Greensand strata rest upon Weald clay, and are everywhere separated from those of the Upper Greensand by an intervening bed of Gault, such a question would be readily determined. But at Blackdown the case is different, the Greensand being there found to rest upon red marl, and the Gault either absent or imperfectly developed; so that, in default of the usual direct evidence, the geologist must be content with such indirect conclusions as can be drawn either from the general appearance of the deposits or from a comparison of the organic remains with those contained in other portions of the Cretaceous series. Whether or not this last method has been carried out by those who consider the Blackdown deposits to be of Upper Greensand age, I have not hitherto been able to ascertain.

In the British Museum all the Blackdown fossils are marked as Upper Greensand, in the Museum of Practical Geology, more cautiously, as Greensand; while in both they are ranged side by side with fossils from Warminster,—a locality where the Upper Greensand is well defined by the presence of the Gault. Now, supposing Upper Greensand deposits to prevail equally at Blackdown and Warminster, one might expect to find a considerable resemblance between the fossils from these two localities; yet, on comparing the specimens, the fact proves itself to be quite the reverse; for, at a rough computation, I find that out of 156* Blackdown

* These and the following numbers refer to Mollusca only.

PLATE IV.



Map of the Greensand Sea.
(BLACKDOWN AGE.)

species of mollusca, 6 only occur at Warminster, the remaining 30 Warminster species not being found at Blackdown. A further comparison of the Blackdown fossil mollusca with those of the Upper Greensand generally, and also with the fossil mollusca of the Gault, gave nearly the same result.

These observations, combined with certain facts which came under my notice while studying the Lower Greensand of Surrey and the Isle of Wight, led me, in the first place, to question the correctness of classing the Blackdown deposits with those of the *Upper* Greensand or even of the Gault; and ultimately induced me to believe them, so far at least as the whetstone strata are concerned, to be exclusively of Lower Greensand origin—their position in the series being, probably, near the base of the upper or ferruginous division of Fitton.

It is, therefore, in the hope of stimulating further inquiries, which, for myself, I have neither the time nor the opportunity to make, that I now venture to address you on the subject, as I feel convinced that a closer investigation of the lowest beds of the Greensand at Blackdown must now decide the question; for, should the absence of Gault be confirmed, I think the evidence of the fossils alone may be deemed conclusive.

The following table shows the relation of the Blackdown fossils to those of the Upper Greensand, Gault, and Lower Greensand respectively:—

Total number of Blackdown species (Mollusca) taken from 'Morris's Catalogue, Fitton's List in Trans. Geol. Society, and from specimens in the British Museum and Jermyn Street Museum, 156. Of these, 81 are peculiar to Blackdown; 20 occur in Upper Greensand, 7 of which are limited to Upper Greensand and Blackdown; 16 occur in Gault, 4 of which are limited to Gault and Blackdown; 59 occur in Lower Greensand, 39 of which are limited to Lower Greensand and Blackdown.

The numbers for comparison, therefore, stand thus:—

Species limited to Upper Greensand and Blackdown, 7; *viz.*—

Ammonites denarius . .	Not common (Sow.).
A. falcatus	A rare species (Sow.)
Pecten asper	Abundant in G. S. near Frome.
Terebratula lyra . . .	Rare.
Turritella granulata . .	Abundant at Blackdown; U. G. S., locality doubtful.
Gryphæa vesiculosa . .	Abundant in U. G. S., near Warminster; Blackdown, doubtful.
Cucullæa carinata . . .	Common at Blackdown; occurs in U. G. S., near Devizes.

Species limited to Gault and Blackdown, 4; *viz.*—

Ammonites auritus . . .	Not common (Sow.).
A. tuberculatus	
Murex calcar	Common at Blackdown; other localities doubtful.
Rostellaria calcarata . .	Common at Blackdown and Folkestone.

Species limited to Lower Greensand and Blackdown, 39; *viz.*—

	Lower Greensand locality.	
Astarte formosa . . .	Shanklin	Rare.
A. obovata	Sandown.	
Avicula Rauliniana . .	Godalming.	
Cardium Hillanum . .	Shanklin	Frequent.
Corbula truncata . . .	Peasemarsh	Common.
C. elegans	Peasemarsh	Common.

Cucullæa glabra	Shanklin and Peasemarsh	Rare.
Cyprina angulata	Hythe and Sandgate.	
C. rostrata	Atherfield.	
Cytherea (Venus) caperata	Atherfield.	
Venus faba	Shanklin and Peasemarsh	Common.
V. ovalis	Peasemarsh	Rare.
Exogyra undulata	Godalming	Rare.
Gervillia anceps	Peasemarsh.	
G. lanceolata	Atherfield.	
G. solenoides		
Lima semisulcata	Shanklin	Common.
Nucula antiquata	Atherfield.	
N. impressa	Parham Park.	
N. lineata	Shanklin.	
N. obtusa	Atherfield.	
Tellina inæqualis	Shanklin and Peasemarsh.	
T. (Psammobia) striatula	Shanklin and Peasemarsh.	
Thetis minor	Shanklin and Peasemarsh	Common.
Trigonia dædalæa	Parham Park.	
T. spectabilis		
T. caudata	Atherfield.	
Littorina pungens	Peasemarsh.	
L. conica	Peasemarsh and Shanklin	Common.
L. (Natica) monilifera	Peasemarsh	Rare.
L. (Natica) rotundata		Common.
Phasianella formosa	Peasemarsh	Rare.
P. striata	Peasemarsh	Rare.
Turbo munitus		
Nautilus elegans	Godalming.	
Dentalium medium	Peasemarsh.	
Serpula filiformis	Shanklin.	
S. plexus		
Vermetus polygonalis	Hythe and Sandgate.	

From the above list, it is apparent that the Upper Greensand and Gault fossils which occur at Blackdown are but few, and of small value when compared with those of the Lower Greensand.

There are circumstances connected with the accumulation and deposition of the strata forming the Lower Greensand generally, which may also be taken into account in considering this question; some of which I shall now proceed to notice.

It has been shown by Dr. Fitton, that the Lower Greensand, wherever fully developed, is separable into three groups or series of strata; each differing somewhat from the others in mineral character, and each possessing a fauna more or less peculiar to itself. Now, although the limits of each are not everywhere traceable, yet there is always a sufficient distinctness between them to warrant the belief that the same causes, whether of upheaval or depression, acted throughout the entire British area then covered by the Greensand ocean.

In the neighbourhood of Godalming this subdivision is, perhaps, more strongly marked than is usually the case. The lower Neocomian clays are here found, as elsewhere, resting conformably upon the Wealden. They are succeeded by a series of strata, composed, for the most part, of fine sand, mingled with more or less argillaceous matter, and including occasional bands of loose, concretionary sandstone; this latter being, apparently, a local equivalent of the Kentish rag of Maidstone. All these appear to have been deposited quietly and continuously, and form, including the lower Neocomian clay strata, "the Middle and Lower division" of Fitton.

Here, however, there is an abrupt change. The finely stratified deposits which have hitherto prevailed are overlaid by an accumulation of coarse sand and *pebbles;* the stratum or strata composed of these materials varying in thickness from a few inches to six or ten feet, and contrasting strongly with the sands beneath. The "pebble-beds" are succeeded by various strata of coarse gritty sand, abounding in concretions of limestone* and chert; in all of which small pebbles and thin layers of clay are of frequent occurrence. These, in turn, are followed by a series of ferruginous sandy deposits of considerable thickness, which range upwards uninterruptedly to the Gault.

It is to the occurrence of these "pebble-beds" and of the superincumbent limestone, in the Greensand of Godalming and elsewhere,† that I would now direct attention, as being possibly connected with the present subject of inquiry.

There is another subject, however, so closely connected with every question relating to the Greensand, that I find myself compelled to notice it before proceeding further.

Mr. R. Godwin-Austen, in a valuable paper "On the possible Extension of the Coal-measures beneath the South-Eastern part of England,"‡ argues the existence, during the Oolitic, Wealden, and Neocomian period, of a *ridge of old rocks* (palæozoic) extending across our south-eastern counties nearly in the line of the North Downs. This ridge the author traces eastward, in connection with a well-marked Continental axis, called by him the "Axis of Artois," and westward, into the district of Bath and Frome. For the capital reasoning upon which that author's supposition is founded, I must refer the reader to the original paper. Yet it cannot fail to strike the observer, that such a ridge, supposing it to have existed as a coast-line during a lengthened period, must have exercised considerable local influence upon the surrounding deposits, whether of the Oolitic or Cretaceous formation; so that the surrounding deposits ought, in themselves, to contain some direct proof of its existence. Such proof, if I mistake not, may really be found in the "pebble-beds" of the Lower Greensand. Of these, Mr. Austen says, "The shingle-beds of the Lower Greensand of Kent and Surrey contain a considerable number of extraneous fossils, such as the bones and teeth of Oolitic saurians, *Ammonites Lamberti* and *Am. crenatus* of the Oxford clay in great abundance, together with *Terebratula fimbria* and *Rhynchonella oolitica;*" and instances these as having been derived from the wearing away of members of the Oolitic group, which, he suggests, may have been originally brought up against the southern slope of this old ridge "by a process of successive overlap."

In confirmation of this opinion I may here mention that, previously to becoming aware of Mr. Austen's researches, I had obtained from the "pebble-beds" of the Lower Greensand of Godalming a series of drifted fossils, ranging in age from the Oxford clay to the Lias inclusive; and, from the evidence of these alone, I had come to the conclusion, that at the time of their deposition in the Greensand the rocks from whence they were derived must have existed within a short distance to the northward.§

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* Locally called "Bargate stone."

† Along the North Downs. A pebble-bed also occurs in the cliff north of Shanklin chine, holding exactly the same position in the Greensand.

‡ Quar. Jour. Geol. Soc. vol. xii. p. 50.

§ My reason for looking northward for such land-surface arose partly from the fact of the pebble-beds becoming gradually thicker, and their component parts coarser, in that direction.

In addition to the fossils mentioned above, I have collected from these "pebble-beds" specimens of the teeth of—

Saurichthys apicalis . .	Fossils of the Trias of Aust cliff and the Lias bone-bed at Axmouth.
S. Mougeoti	
S. ?	
Hybodus Minor	
Acrodus minimus . . .	
Hybodus pyramidalis . .	Fossils of the Lias.
H. reticulatus	

H. grassiconus.
H. ?
Lepidotus (two or more species in abundance).
Sphærodus ?
Gyrodus.
Pycnodus Mantelli.
Acrodus.
Strophodus ?
Lamna longidens.
Notidans.

and some others. The greater number of these specimens are more or less broken; yet many of them are by far too perfect and delicate to have been drifted from a distance. I have also, from the same deposits, casts of about thirty species of small univalve and bivalve shells, which, at present, I have had no opportunity of identifying.

The "pebble-beds," therefore, appear to offer double evidence in regard to this "old ridge:" firstly, in affording a proof of its existence as a coast-line; and secondly, in pointing out a time of its partial submergence: with the latter evidence I have now to do.

A thin stratum of sand, clay, and *pebbles* (described by Fitton as a "kind of gravel"), occurs at the base of the Lower Greensand, at its junction with the Wealden. Again, the basement-bed of the Gault, as at Redcliffe, contains numerous *subangular pebbles.* In both of these cases the pebbly strata represent a change in the relative level of land and water, sufficiently extensive to have altered the character of the succeeding deposits; and thus it seems probable that the "pebble-beds" at the base of the upper division of the Lower Greensand represent a similar disturbance; the effect of which, I think, may be easily traced.

No Greensand deposits older than the "upper" or ferruginous division of Fitton are found to the west of a line drawn from Warminster to the Isle of Purbeck, or north of a line passing from Dover, through Rochester, Croydon, Kingsclere (Hants), and then on to Warminster, or, in other words, north of Godwin-Austen's "old ridge." Greensand deposits, however, corresponding to Fitton's upper division, are found greatly to exceed these limits, both on the north and west. It appears, therefore, to be tolerably certain that the "pebble-beds" at the base of the ferruginous division represent, and are the immediate result of, a period of considerable depression, during which the Lower Greensand ocean extended itself far to the northward, across a portion of the "old ridge," and westward into Devonshire. By supposing this ridge to have been cut through or partially submerged at this period, one difficulty, at least, as regards the "pebble-beds," will be done away with—viz. that of the occurrence in one stratum of the fossils of several separate formations. For, supposing such a ridge to have existed as a land-surface from a period prior to the deposition of the Lias, every succeeding deposit must have been brought up against it, as has been suggested by Mr. Austen; and, consequently, an oceanic current, in crossing this line, would act upon the edges of these various deposits, and thus mingle in one stratum the débris of many. It would, further, serve to connect the "pebble-beds" of Surrey with similar deposits in the Lower Greensand near Devizes, and also with such part (at least) of the Faringdon gravels as are generally recognized as of Lower Greensand age. The mineral character is the same in each, and the fossils are also found to bear a close resemblance. The "pebble-beds" of Godalming contain *Rhynchonella depressa*, *R. latissima*, *R. nuciformis*, *Terebratula Nerviensis*, *T. oblonga*, *T. faba*, *T. ovata*, (?) *T. tamarindus*—the first four rarely, the latter in abundance; all of which species have been found at Seend, near Devizes, and also at Farringdon.

To the first part of this argument—viz. a northern, or rather north-eastern, extension of the Greensand at this period, no objection is likely to be made. A western extension at the same period, however, does not so readily admit of proof; yet it is so very probable, that, for the sake of argument, I will suppose the fact to be admitted. In which case, the lowest beds of the Greensand in Dorset and Devonshire would be nearly equivalent in age to the "pebble-beds" of Godalming; and the position of the "Whetstone" beds of Blackdown, from which the greater portion of the Blackdown fossils are obtained, would correspond with the concretionary, siliceous, and calcareous deposits which so frequently occur near the base of the ferruginous division of the Lower Greensand of Kent and Surrey, etc. As, for instance, the concretions in the cliffs between Folkestone and Copt Point, described by Fitton as "in part consisting of siliceous, spongy stone, like the Whetstone of Devonshire;" the Bargate stone of Godalming, in which siliceous, spongy concretions also occur; the siliceous and ferruginous concretions in the cliff, which form the upper part of Shanklin chine, and the ferruginous nodules in the Greensand at Parham Park. The fossils from these localities, though few in number, are mostly such as occur at Blackdown. Thus, from the Bargate stone of Godalming, in which shells are very scarce, I have obtained *Avicula Rauliniana*, *Exogyra undata*. and *E. undulata*; from Shanklin, *Astarte formosa*, *Cardium Hillanum*, *Psammobia striatula*, *Tellina inæqualis*, *Gervillia lanceolata*, *Thetis minor*, *T. lævigata*, *Venus faba*, *Lima semisulcata*, *Nucula impressa*, *N. lineata*, *Pecten quinquecostatus*, *Pinna tetragona*, *Corbula elegans*, *Trigonia caudata*, *Littorina conica*, *L. monilifera*, and *L. rotundata*. In fact, these last-named deposits contain a greater percentage of Blackdown fossils than occur in any other portion of the Cretaceous series; and this, alone, is in itself the strongest argument which could be used in favour of the Lower Greensand age of the Whetstone deposits.

In the accompanying map I have endeavoured to show the probable position of land and water at two distinct periods: the darker shading represents the probable extent of the greensand ocean over our south-eastern counties during the accumulation of those deposits which are included in Fitton's middle and lower division; the lighter shading exhibits its further extension to the north-east and west, during and after the accumulation of the "pebble-beds," and previously to the deposition of the Gault.

In this map Mr. Godwin-Austen's "old ridge" forms the northern boundary of the Greensand during the first period. At the second period the greensand is seen on the north—the ridge being partially submerged. It is probable that this ridge became wholly submerged during or immediately before the deposition of the Gault.

Allowing the position of the land-surface to have been as above stated, the abundance of the Blackdown fossils, as compared with those in the upper division of the Greensand in Surrey, etc., would not be at all surprising; for the position of Blackdown, near the end of a narrow inland bay, would have been, of all others, the most favourable one for the increase of mollusca.—I am, Sir, yours, etc., C. J. A. Meyer.

Godalming, Surrey.

Elephas Texianus v. *Columbi.*

Sir,—Reference has already been made by me to the above subject in the pages of the 'Geologist.'* The nomenclature which I have used, and the inferences which I have drawn, having been impugned in an elaborate paper by Dr. Falconer,† a few lines in their justification may be permitted.

When, in February, 1858, the tooth in question was shown to me by my friend Mr. Bollaert, the most casual observation was sufficient to demonstrate that it was of a different species to the Mammoth (*E. primigenius*). In the dearth of published information on the subject I consulted the works of Cuvier,‡ Humboldt, § Leidy, || De Blainville,¶ Carpenter,** Lartet,†† and others, and especially the memoir of Dr. Falconer.‡‡ I endeavoured in the paper on the Texan Elephant to acknowledge the benefits to proboscidean science derived from his "most complete, elaborate, and philosophical conspectus."

Upon attempting, with the "Bollaert molar" in my hand, to discover in this memoir any specific description of this form, my efforts resulted in disappointment. Dr. Falconer, in the above-cited memoir, divided his subgenus *Euelephas* into four divisions. The first he characterizes as having "*Colliculi subremoti, adamante crassiusculo.*" The solitary species belonging to it is the Miocene *E. Hysudricus*. The second division (*Colliculi approximati, medio leviter dilatati, machæridibus undulatis*) includes *E. antiquus* and *E. Namadicus*. The third division (*Colliculi approximati, machæridibus valde undulatis*) includes *E. Columbi*, *E. Indicus*, and *E. Armeniacus*. The fourth division (*Colliculi confertissimi, adamante valde attenuato, machæridibus vix undulatis*), has for its solitary representative the mammoth (*E. primigenius*).

The name *E. Columbi* has the following notes added to it in Dr. Falconer's Synoptical Table:—

Geological Age.	*Country.*	*Remarks.*
Post-pliocene?	Mexico.	An syn. *E. Jacksoni?*
	Georgia.	Sillim. Journ., 1838,
	Alabama.	vol. xxxiv. p. 363.

In the second part of his paper, which was read before the Geological Society on June 3, 1857,§§ Dr. Falconer concluded with a few remarks on the non-existence of *E. primigenius* south of the Alps, and its restric-

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* Geologist, vol. iv. p. 470; vol. v. pp. 57 and 323.

† 'On the American Fossil Elephant of the Regions bordering on the Gulf of Mexico (*E. Columbi*, Falconer), with General Observations on the Living and Extinct Species." Natural History Review, January, 1863.

‡ Ossemens Fossiles, ed. 1834, vol. iv. p. 145.

§ Cosmos, vol. i. p. 280.

|| Nebraska Fauna, p. 9.

¶ Ostéographie, Eléphans, p. 157.

** Silliman's Journal, second series, vol. i. p. 244.

†† Bull. Geol. 1859, p. 469.

‡‡ Quarterly Journal Geol Soc., 1857, p. 319; 1858, p. 81.

§§ Quarterly Journal Geol. Soc., vol. xiv., 1858, p. 81.

tion in the United States of America to the Northern and Central States. "In the Southern States and Mexico, a distinct fossil species, *E. (Euelephas) Columbi*, hitherto undescribed, occurs along with remains of *Mastodon, Mylodon, Megatherium*, horse, etc."

Dr. Falconer tells us,* that by the above description "the leading points of the dental characters and the precise place in the natural series occupied by the species were distinctly indicated, together with its range of habitat, along a stretch of nearly 20° of longitude in the regions bordering the Gulf of Mexico."

Apart from the incongruity of the assertion that Georgia is included in the "regions bordering the Gulf of Mexico," I cannot perceive in Dr. Falconer's group-characters, "*Colliculi approximati, machæridibus valde undulatis*," such a definition of the specific signification of *E. Columbi* as is imperatively demanded at the hands of the founder of a new species. The mere insertion of the above notice in a catalogue, I have already ventured to suggest, was not a valid definition. Still less was it so, when in the column of remarks the following bewildering announcement was inserted, "An Syn. *E. Jacksoni?* Silliman's Journal, 1838, vol. xxxiv. p. 363." The worthlessness of the representations here contained has been already commented on by me, and Dr. Falconer admits that the only published drawing possibly attributable to *E. Columbi*, to which he was able to refer at the time of his memoir in 1857, was "too imperfect to be reliable for more than a conjecture."†

Dr. Falconer, criticizing my specific definition of *E. Texianus* (*dentium molarium* (m. 6), *colliculi undulati, magis remoti quam in E. Indico*), says that he fails "to detect a single term or character which is not either expressed, embodied, or implied, in his Synoptical Table above referred to." I, however, have searched this table most carefully for any hint that the "*colliculi*, or constituent ridges of the unworn teeth," in *E. Columbi* are further apart (*magis remoti*) than in the Indian elephant, and do not discover any such implication. Dr. Falconer, in his later memoir, subsequently to the publication of my paper,‡ speaking of the Mexican molar in the College of Surgeons, says: "The disks of wear are wide and open, wider than in the ordinary varieties of the existing Indian elephant, and approaching the width commonly presented by *E. antiquus*. But they differ from those of the latter species in showing no angular expansion in the middle of the disks, and no outlying loop at the angles. In this respect they correspond more with the disks of the existing Indian elephant."

In the quotation from my published paper to which Dr. Falconer refers on page 48 of his memoir, a grave orthographical blunder has been inserted, which is not found in the original, as may be seen by those who compare Dr. Falconer's version with page 58 of the 'Geologist' for 1862. I have there said that "as it is not clear whether *E. Columbi* is named in honour of Columbus, or because it is found in Col*o*mbia (Venezuela y Nueva Granada), I trust that this name will not be accepted." In the passage, which purports to be a faithful and literal quotation of my words, the word Col*o*mbia has been altered to Col*u*mbia, and my meaning has been rendered open to misconstruction on the part of those who might consider me guilty of the orthographical solecism which Dr. Falconer has attributed to me.

But Dr. Falconer goes on to say, that Columbia (meaning Colombia) was "nowhere in question as a habitat of the species." I confess I am a little surprised at this statement, seeing that the frequent presence of Mastodon remains in the plateaux of New Granada has been discussed;

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* Nat. Hist. Review, vol. iii. p. 45.

† Id. p. 57.

‡ Page 50.

that in September, 1858, Professor Owen had speculated on the possibility of evidences of proboscidean life "at the expense of the still more luxuriant vegetation watered by the Oronoko, the Essequibo," etc.;* that in districts even more remote than Colombia, Dr. Falconer, on the testimony of M. Lartet,† has arrived at the conclusion that it is possible that *E. Columbi* may have even reached so far south-east as Cayenne, in latitude 4° 56′ N., and longitude 52° 8′ W., and that a doubtful evidence of true elephantine remains was discovered by Humboldt in the province of Quito.

With respect to the "jactitation" and "accommodating arrangements" which Dr. Falconer presumes to exist between Professor Owen and myself, respecting the synonymy, the simple fact to which I alluded in my paper—that I had examined the tooth in February, 1858, and when I had arrived at a definite opinion as to its position in the Elephantine series, Professor Owen, in his address to the British Association, thought fit to adopt my name—affords a satisfactory explanation of the alleged discrepancy.

I was necessarily ignorant of the private information placed at Dr. Falconer's disposal at various periods of time, ranging from the year 1846 to the present year, by Sir Charles Lyell, M. Humbert, Messrs. Norton, Guild, and others, when my memoir was published. I however made due reference to the milk-molar brought by M. Le Clerc from Texas, now in the Paris Museum, as possibly belonging to the same species as *E. Texianus*. Two of the specimens from the Huff collection in the British Museum, which I had been inclined to refer to *E. primigenius*, are considered by Dr. Falconer to belong to *E. Columbi*. The other colossal remains are admitted by him to be indistinguishable from *E. primigenius*. The specimen No. 741A, in the Museum of the Royal College of Surgeons, I have examined carefully since the publication of Dr. Falconer's paper, and I have no hesitation in recognizing it as referable to *E. Texianus*.

When speaking of the "Bollaert molar," Dr. Falconer states that "some of the plates show a considerable amount of undulation in the general sweep of the *machærides*, but there is no tendency to the mesial expansion, or outlying loop, seen in *Elephas antiquus*."‡ The degree of mesial expansion in *E. antiquus* (*medio leviter dilatati*, Syn. Table) seems to be scarcely defined. According to Lartet,§ who describes *E. meridionalis* as a separate species, "leur émail, irrégulièrement festonné, offre le plus souvent une expansion médiane simple ou double, qui rappelle, jusqu'à un certain point, les figures rhomboïdales que la détrition produit sur les molaires de l'éléphant d'Afrique." Lartet, describing the *E. antiquus*, says, "émail moins épais et plus régulièrement festonné, avec ou sans expansion médiane." With due respect to Dr. Falconer's elaborate description of this "magnificent morceau," I can detect in the fourth and fifth ridges of the tooth, or the second and third of the seven ridges which are "bounded by highly crimped and thick plates of enamel," evident traces of a mesial expansion, which may be considered *pro tanto* homologous with that of *E. antiquus*, so far as the definition of a "mesial expansion" in that species is capable of comprehension. A slight mesial expansion may also be seen in the seventh ridge of the Mexican molar in the College of Surgeons.

Dr. Falconer's criticisms on the vagueness of the geographical name which

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* Owen, 'Address to the British Association at Leeds,' p. 39.

† Falconer, Nat. Hist. Review, p. 60.

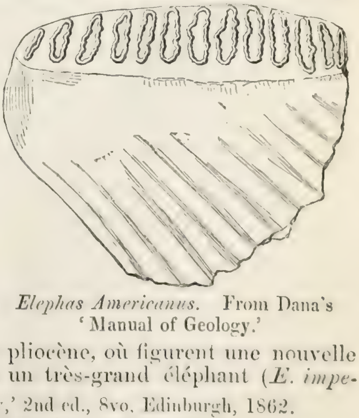
‡ *Loc. cit.* p. 52.

§ "Sur la dentition des proboscidiens fossiles, et sur la distribution géographique et stratigraphique de leurs débris en Europe." Bull. Geol. 1859, p. 469.

I proposed for the Texan elephant are, to a certain extent, neutralized by the fact that in his Synoptical Table, such "geographical names" are retained and put forth into circulation, as *Ohioticus*, Blum.; *Pyrenaicus*, Lartet; *Andium*, Cuvier; *Perimensis*, Falc.; *Arvernensis*, Croizet and Jobert; *Sivalensis*, Falc.; *meridionalis*, Nesti; *Africanus*, Blum.; *Hysudricus*, Falc.; *Indicus*, Linn.; *Armeniacus*, Falconer. It there appears that out of the twenty-eight species of *Elephas* and Mastodon known, at least eleven have names given founded on their regional habitats, for four of which names Dr. Falconer is individually responsible. In the same memoir in which he tells us "the distinctive characters of species are commonly founded on something more intrinsic and tangible," he actually proposes to add another "geographical name" to the list, to denote the pigmy elephant of Malta (*E. Melitensis*, Falconer).

Other original observers have alluded to the diversity of species in the American elephants. "It appears that the Mammoth (*E. primigenius*) ranged quite as far north in America as it did in Europe at one time, and indeed much further south (Sir Charles Lyell's 'Travels in North America,' vol. ii. p. 58), if the identification of its remains by the American geologists be a correct one, and there be no other species there corresponding to the *Elephas antiquus* or *priscus* of Europe."* In the 'Geologist' for April, 1861, a note appears, by Mr. G. E. Roberts, on the occurrence of a large elephantine beast in Texas, at the junction of the rivers Guadalupe and Comal.

In the recently-published geological text-book of Prof. Dana, it is stated:† "The American elephant ranged from Georgia, Texas, and Mexico on the south, to Canada on the north, and Oregon and California on the west. A tooth was found in ancient alluvium near the Colorado, 114½° W. and 35¾° N. (Newberry). Parts of one skeleton were dug up in Vermont, at Mount Holly, 1415 feet above tide level. The species appears to have been most abundant to the south, in the Mississippi valley, it preferring a warmer climate than that of *E. primigenius*. Fig. 837 [labelled *E. Americanus*] represents one of the teeth found in the state of Ohio. . . . The elephant in northern North America, in the British possessions, is supposed to have been the Siberian species." Dana states elsewhere,‡ that the *Elephas primigenius* seems not to have gone far south of the parallel of 40°. Dana's figure is copied from a manuscript Palæontological Report of Warren's Expedition to the Upper Missouri, by Meek and Hayden. The tooth exhibits twelve, or perhaps thirteen, enamel disks, of which the sixth and seventh show evident traces of the "*expansion médiane*" on which Dr. Falconer lays so much stress. I am, however, very doubtful to what species this can be referred. Lartet has already told us:—"Les dernières publications de M. le professeur Leidy, de Philadelphie, viennent de nous révéler l'existence dans l'Amérique du nord d'une faune pliocène, où figurent une nouvelle espèce de mastodonte (*M. mirificus*) et un très-grand éléphant (*E. impe-*



Elephas Americanus. From Dana's 'Manual of Geology.'

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* Jukes, 'Student's Manual of Geology,' 2nd ed., 8vo, Edinburgh, 1862.

† Dana, 'Manual of Geology,' 8vo, Philadelphia, 1863, p. 562.

‡ *Loc. cit.* p. 560.

rator). Trois autres proboscidiens ont vécu dans l'Amérique du nord pendant la période post-pliocène ou quaternaire; ce sont l'*Elephas Americanus,* que M. Leidy considère comme étant distinct de l'*E. primigenius,* l'*E. Columbi,* Falc., des Etats du Sud et du Mexique, et le *Mastodon Ohioticus,* que quelques auteurs supposent avoir été contemporain des premiers hommes qui se sont établis dans cette région du globe." Whilst, however, I decline to offer any opinion whether the tooth figured by Meek may be referable to the *E. imperator* of Leidy, from Niobrara, I copy Dana's woodcut in the margin.

I have previously and frequently expressed the utmost deference to the palæontological authority of Dr. Falconer, whose constant study of the fossil specimens, thorough knowledge of the habits and food of the existing Indian elephant, and exhaustive acquaintance with proboscidean bibliography, must command respect amongst comparative anatomists. The foregoing remarks have, however, been called for to re-assert my title to be the first who directed attention to the "Bollaert molar," and to claim the undoubted privilege of every scientific man to describe any species of which no full, complete, and accurate definition has been previously promulgated.

Yours truly,

C. Carter Blake.

Obituary Notice.

LUCAS BARRETT, F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF THE BRITISH WEST INDIES.

The last West India mail brought letters and papers announcing the premature loss of this amiable and accomplished naturalist, so lately among us taking an active part in the proceedings of the British Association at Cambridge.

He left England on the 17th of October last, and returned to Jamaica, accompanied by Mr. W. P. Colchester, eldest son of the gentleman who has for some years been the contractor for all the fossil phosphates of the Crag district and Cambridgeshire. He had formerly made a few very promising dredgings on the coast, at considerable depths; and being anxious to explore those portions of the sea-bed (between low-water and the limit of coral—perhaps about 15 fathoms) which are inaccessible to the dredge, he took out with him a diver's dress and pumping apparatus of the most approved construction, such as Mr. Heinke has supplied to all the stations of the Peninsular and Oriental Company, and which has been so successfully employed in recovering the wrecks of the 'Malabar,' 'Colombo,' and 'Royal Charter.' Dr. Bowerbank, of Kingston, writes word that he met Mr. Barrett on the 18th December last, in the House of Assembly, where he had gone to give evidence before a committee. He then told Dr. B. that he had been down the day before (in his diving-dress) in shallow water, and had succeeded well, and intended trying deeper water for the purpose of examining the coral reefs. Dr. Bowerbank begged him to wait till he could go with him; but he replied that "he would see." Other friends also warned him not to go, and offered to accompany him if he would defer it for a day; but he went, attended only by the boat's crew of negroes and his (negro) servants. Mr. Colchester happened to be away at the time, at the Pedro Keys. He says that "according to the evidence given by the men, Mr. Barrett went direct down from the boat into deep water by means of a rope-ladder. The pumps were worked uninterruptedly, as on the former occasion; but they noticed that he remained below longer than previously (which, according to his own statement, had been half an hour), and suddenly, to their horror, they observed his body floating at the surface of the water, a little distance from the boat. They got to him as quickly as possible, without ceasing pumping (so they declare), and on the removal of the helmet found him apparently dead. Without knowing in the least what to do, they took him on shore—some distance; but, of course, it was all over then, if it had not been long before." The verdict, at the inquest, made it appear that water had got into the air-tube at the joint, which was not screwed up tight enough; but this Mr. Colchester (and also Mr. Heinke) regarded as impossible. No water seems to have been found in the dress; and the rising to the surface, with all the weights upon him, could only have occurred by the valves for the escape of the air being closed. There is a small escape-valve in the helmet which is closed by a spring, and does not act until the pressure of the air is more than sufficient to cause the diver to rise. The principal valve is in the breast of the dress, and is closed by a lever, requiring the action of the hand. Now it appears that Mr. Barrett had neglected the precaution (which is always made imperative) of attaching the life-line to his body, preferring, he said, to hold it in his hand. If by any chance he lost this rope, he would lose his means of communicating with the crew, and become entirely dependent on the air-tube. His only means of rising to the surface would be by closing the escape-valve, which he must have done for this purpose, perhaps, on finding that something had gone wrong. All the inquiries hitherto made have left a painful doubt, which time will scarcely remove.

It has appeared desirable to give these particulars, because it looks like an instance of self-reliance carried too far, and a valuable life sacrificed, apparently, by the neglect of those precautions which any one less daring would have observed. The divers professionally employed work four hours at a spell, often inside the hulls of vessels; they are said even to have gone to sleep below! The only casualties have been one or two apoplectic seizures, which have occurred to men in government works, who probably were not fitted for the occupation.

Lucas Barrett was born in London, November 14, 1837. He was the eldest son of Mr. George Barrett, the iron-founder, whose works at the Record-Office and King's Cross Terminus are well known. He was sent, in 1847, to Mr. Ashton's school, at Royston, Cambridge, and afterwards to University College School, and in his holidays used to visit the British Museum, where he soon became known to the Natural History officers, by bringing fossils to be named, and volunteering to assist in unpacking and sorting collections. In 1853, he went to Ebersdorf, near Lobenstein, Voigtland, where he remained a year studying German and chemistry; and making, in the course of it, a pedestrian tour in Bavaria, which deserves to be recorded, as having cost him only one shilling a day. In 1855, he accompanied Mr. M'Andrew in a yachting voyage to Norway and Finmark, and made some observations on the living *Terebratulæ*, which were published in the Ann. Nat. Hist., and translated into the scientific journals of France and Germany. The same year he was chosen successor to Mr. M'Coy, as Curator of the Cambridge University Museum, and was elected a Fellow of the Geological Society of London, although perhaps legally ineligible, being only eighteen years of age. In the following year he obtained leave of absence, and accompanied Mr. J. W. Tayler to Greenland,—an expedition attended with considerable expense and no small amount of hardship, of which no account has been published; but there is a suite of specimens of shells, etc., collected by him, in the British Museum. In 1857, he again accompanied Mr. M'Andrew in a voyage to Vigo (the last cruise of the 'Naiad'), and added extensively to his collection of *Echinodermata*. Still, nothing was published except a short communication (by himself and Mr. Woodward), in the Proceedings of the Zoological Society, on the genera *Synapta* and *Cheirodota*.

During his custody of the Cambridge Geological Museum, many considerable additions were made and arranged by Mr. Barrett: such as the Saurians from the Lias, presented by Mr. T. Hawkins; the beautiful collection of Chalk fossils bequeathed by Dr. Forbes Young; and the local collection of the Rev. T. Image. The rapid and extensive development of the use of fossil phosphates from the Upper Greensand around Cambridge, supplied him with a new field of research; and early in 1858 he had detected two bird-bones, and numerous remains of several distinct species of Pterodactyle (some of extraordinary size), which have been figured and described by Professor Owen in the Transactions of the Palæontographical Society. He had also prepared a geological map of the vicinity of Cambridge, of which a second edition was published (by Macmillan) in the last year.

In 1859, he was appointed by Sir H. Bulwer to the important post of Director of the Geological Survey of the British West Indies, chiefly, it is understood, upon the recommendation of Professor Phillips. The salary and allowance for expenses, £700 a year, was raised to £800 soon after he had commenced his duties; and the sphere of occupation opened to him was every way worthy of his versatile and enterprising genius. The number of the 'Geologist' for last October contains a figure and description of a marvellous fossil discovered by him in Jamaica, and named after him, very much against his wish.

But although so well occupied in Jamaica, he must have retained a strong regard for Cambridge, where so much of his young life was passed. He had frequently lectured for Professor Sedgwick, and was such a favourite, that had he been a little older, and a graduate of the University, he would have been regarded as the probable successor to the Geological Chair. Some time before leaving England he was persuaded to enter Trinity College; and last year, when he came over as Commissioner for Jamaica to the International Exhibition, he resided and kept his Terms at Cambridge.

Of all the younger naturalists of the day he approached most nearly to Professor E. Forbes, in the sweetness of his disposition, his instinctive good taste, and the brightness of his intelligence; inferior, however, to Forbes in two respects, inasmuch as he never showed an aptitude for public speaking or writing. It may have existed in him, and would possibly have developed itself, had his life been spared. As it is, he served but for a little space to hold the lamp of science committed to him by some who trusted that he would long continue to hand onward that glorious light when they should have passed away. S. P. W.

FOREIGN INTELLIGENCE.

The topographical survey of Spain, under M. Coello, the accomplished geographer, is making progress. The triangles of the first order have been made for the whole kingdom, and those of the second order have been completed for the province of Madrid. The maps are on the scale of $\frac{1}{1000}$ for the country, and $\frac{1}{500}$ for cities. The geological department has completed its work in the provinces of Burgos, Santander, and Madrid; and those of Leon, Zamora, and Avita, are in progress.

The Transactions of the American Philosophical Society, vol. xii. (parts i. and ii.), contains the "Geology and Natural History of the Upper Missouri," with a map, by Dr. F. V. Hayden. In the 'Journal of the Philadelphia Academy' (vol. v., part ii., October, 1862) there is a "Monograph of the Fossil Polyzoa of the Secondary and Tertiary Formations of North America," by Mr. Gabb and Dr. Horn, with beautiful lithographic plates by Ibbotson; and an article on the "New Unionidæ of the United States and Arctic America," by Mr. Isaac Lea. The number of species described or known to exist were stated by Mr. Lea, in 1860, as,—*Unio* 465, *Margaritacea* 26, *Anodonta* 59,=550; to which he added, as not described, 30 in his own cabinet, 36 from North America, Mexico, Honduras, and Central America, and 1 from Canada; in all 617. Since then he has produced the above, and a previous paper containing further additions.

Professor Dana's 'Manual of Geology' has appeared (Trübner, 1863, 8vo, pp. 812). It treats the science with special reference to American Geological History, for the use of colleges and schools of science. The work is divided into four parts:—I. Physiographic; II. Lithological; III. Historical; and IV. Dynamical Geology.

The 'Canadian Naturalist' for October contains a letter "On the Cattskill Group of New York," by Professor James Hall. Late investigations, he says, have forced upon him the conviction that the greater part of the area coloured on the Geological Map of New York as Cattskill Group is in reality occupied by the Portage and Chemung Groups. Several years since, in making sections across the country from north to south, and through the counties of Albany and Schoharie, he ascertained that the Hamilton Group, as indicated by its well-marked and characteristic fossils, extends to the southern limit of the colouring indicating the Chemung Group on the Geological Map. He is prepared to show now that the Hamilton Group in the counties of Albany, Greene, Schoharie, Otsego, and a part of Chenango, with the exception of some outlines on the higher hills, occupies nearly the entire belt coloured as Chemung, the southern line corresponding very nearly with the limit assigned to that formation; thus leaving the Chemung Group, with its southern limits, still unassigned. Until within a few years, the State collection had been nearly destitute of fossils from the rocks of Delaware county, according to the map, Cattskill Group. Some time since, Professor Orton, of the Normal School, Albany, sent specimens which were recognized as characteristic of the Chemung Group; but as it was possible they might have been derived from transported masses, no decision was come to. More recently, Mr. J. M. Way, of Franklin, Delaware county, has found fish-remains in considerable abundance; from loose and scattered masses he has traced the specimens to their position in the hill-slopes, and has ascertained the existence of no less than three distinct beds containing these ichthyic remains. Associated with these, he has found numerous shells typical of the Chemung Group. Professor Hall describes these strata and their contents in detail. There is also a letter by Colonel E. Jewett on the same subject.

Mr. Roff, C.E., of Montreal, read before the Natural History Society, in November, a paper "On the Superficial Deposits of Canada." On this subject Dr. Dawson, in Lower Canada, has made many valuable contributions; and in the Upper Province, Professor Chapman, of Toronto, and Mr.

Robert Bell, under the direction of Sir Wm. Logan, have thrown much light upon the subject. These three accomplished observers are agreed in dividing the superficial deposits, or drift, of Canada, into an upper and a lower member; the former consisting of dark blue and greyish clays, the débris of the underlying limestone, and nearly destitute of boulders; the latter of sand and gravel of granitic or gneissoid origin, with numerous boulders. Throughout Lower Canada, and as far west as Kingston, the relative age of this deposit has been determined by appropriate fossils of recent or existing species; and although these are wanting in the Upper Province, the analogy is presumed to be established by other characteristic features.

The fact to which the author specially draws attention is, that the older formation prevails almost exclusively in western Canada on the elevated platform bounded on the north and east by the Niagara escarpment, which sweeps round in a bold and abrupt manner from the Niagara, the head of Lake Ontario, and northward to Cabot's Head, on Lake Huron, forming a very marked feature in the physical geography of the province. The whole of the country for a great distance to the east, by this line, and especially towards the base of the escarpment, is thickly strewn with sand, gravel, and boulders of Laurentian origin; while to the west these are of very rare occurrence, and are replaced by materials evidently derived from the disintegration of the underlying limestone. From the Niagara escarpment westward to the height of land near Woodstock, this difference is less marked than from that point still further west to the shores of Lake Huron. The inference to be drawn from these facts, Mr. Roff thinks, confirms the opinion of Lyell and others who have examined the physical geography of Canada, that the contour of the fundamental rocks of the country was impressed at an epoch long anterior to the glacial or drift period, and that the elevated platform of the western peninsula, if not actually above the level of the sea at that period, was sufficiently high to resist the intrusion of ice-islands charged with the débris of the Laurentian and other ancient northern rocks which would be drifted by the glacial currents from the north-east.

NOTES AND QUERIES.

Didymodon Vauclusianum.—[The following note was accidentally left out of Mr. Blake's paper in last month's 'Geologist.'] I have been led to consider the last tooth in the jaw as the third molar, by reason of the shape of the impression indicating the insertion of the pterygoid muscle immediately beneath it, rendering it very improbable that any tooth can have existed behind it in the jaw. C. C. Blake.

Kitchen-Middens of New Zealand.—Mr. Lubbock has, in an able and interesting memoir in a late number of the 'Natural History Review,' described a series of shell-deposits in Denmark termed "Kjökkenmöddings," or kitchen-middens, being the heaps of waste shells and other débris, thrown aside after their feasts by the ancient human inhabitants of the country.* It may not be uninteresting to know that deposits similar to the "Kjökkenmöddings" are still in course of formation, though not perhaps in Europe. In New Zealand, large heaps of shells, often six or eight feet in thickness, are common near the shore. These are most frequently met with near native villages, but it is by no means uncommon to find them far from any trace of Maori dwellings. I have never seen any human bones in these, though from the former cannibal habits of the aborigines of New Zealand, it might be anticipated that some human remains would be found, and indeed on closer examination such may be discovered.

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* 'Natural History Review,' vol. i., 1861, p. 489.

These kitchen-heaps are composed chiefly of the shells of one species of bivalve mollusk, called by the natives *pipi*, which is still plentifully taken and eaten, though not so much so as before the European occupation of the country. The natives now have a better supply of animal food than formerly, in the pigs, poultry, and oxen introduced by the Europeans, and are not so dependent on the produce of the sea and rivers.

This note may perhaps serve as a hint to some future traveller to examine more attentively than I did the shell-heaps formed of the débris of Maori feasts. Useful comparisons may thus possibly be elicited between these remains and the Kjökkenmöddings of Denmark, and those found at the Pileworks of Switzerland. R. Lechmere Guppy.

Trinidad, 29th November, 1862.

Newfoundland.—The 'Canadian Naturalist and Geologist' for October contains "Observations on the Geology and Physical Characteristics of Newfoundland," by the late President of the Natural History Society of New Brunswick, M. H. Perley, Esq. The paper first gives a description of the physical features of the island, and then reviews the former labours of Mr. Jukes, adding to the statements of what was accomplished by him the subsequent observations of the author himself.

Gypsum is abundant at Cadroy, and a splendid white marble on the Humber. Ores of copper have been found in several districts, and explorations have been carried on by various parties, whose discoveries have not yet been made public. An extensive deposit of lead has been found at La Manche, in Placentia Bay, and worked for a short time by an American company.

Jaws with Teeth in the Archæopteryx Slab.—In the counterpart slab of the Archæopteryx is a portion of bone with four or five teeth, which has caused some little excitement, under the idea that it might be the jaw of that bird. Mr. Davies considers it the upper part of the head of a lepidoid fish (maxillary bone), an opinion in which we are disposed to concur, but at present we wish only to notice the fact, not having been able to fully examine the case in time for publication in this number. We would suggest a fair comparison of these teeth and portion of jaw with the corresponding parts in the various species of Pholidophorus and Lepidotus, and we should be glad of the loan of good specimens for the purpose—the specimens in the National Collection not being sufficiently perfect, as respects the head, for this special examination.

Scotch Crocodiles.—The following announcement appears in a contemporary :—"A rumour, of which confirmation is promised, has reached us, that the skeleton of a crocodile has been discovered in the old red sandstone in the neighbourhood of Elgin. If true, it marks another epoch in geological science, as the fossil remains hitherto found in that formation have been of creatures much lower in the scale of organization." We thought that the white sandstone near Elgin, long erroneously regarded as of Devonian age, had been proved to be Mesozoic, and that reptiles apparently of some crocodilian affinities (*Stegonolepis*) had already been discovered therein. The assertion that the present rumour "marks another epoch in geological science" seems to us one of those premature deductions which have been elsewhere stigmatized as "the fabulous excrescences of a credulous and gossiping zoology."

Subdivisions of British Rocks.—We find space for the following list of the subdivisions of British rocks, as recognized by the Geological Survey, believing it will prove useful to many of our readers.

Blown sand.		
Alluvium.		
Peat.		
Raised beaches.		Post-Tertiary and recent.
Cave-deposits.		
Valley, or low-level gravel.		
Brick-earth.		
High-level gravel.		Newer Pliocene.
Glacial drift.		
Till and boulder clay.		
Cave-deposits.		Older Pliocene.
Mammaliferous (Norwich) crag.		
Red crag.		
Coralline crag.		
Leaf bed of Mull.		Miocene.
Lignite of Antrim.		
Bovey beds.		
Hempstead beds (Isle of Wight).	Fluvio-marine.	Upper Eocene.
Bembridge beds.		
Osborne beds.		Middle Eocene.
Headen beds.		
Upper Bagshot sands.		
Barton clay.	Middle Bagshot.	
Bracklesham sands and clays.		
Lower Bagshot sands and clays.		
London clay.		Lower Eocene.
Bognor beds.		
Woolwich and Reading beds (plastic clay, with sand, pebble-beds, etc.).		
Thanet sands.		
Upper chalk.		Upper Cretaceous.
Lower chalk.		
Chalk marl.		
Chloritic marl.		
Upper greensand.		
Gault.		
Folkestone beds.	Lower Greensand.	Lower Cretaceous.
Sandgate beds.		
Hythe beds, or Kentish rag.		
Atherfield clay.		
Weald clay.		
Upper Tunbridge Wells sand.	Hastings Sand.	
Grinstead clay.		
Lower Tunbridge Wells sand.		
Wadhurst clay.		
Ashdown sands.		
Ashburnham beds.		

Upper Purbeck beds.	Purbeck beds.	Upper Oolite.
Middle Purbeck beds.		
Lower Purbeck beds.		
Portland stone.	Portland beds.	
Portland sands.		
Kimmeridge clay.		
Upper Calcareous grit.	Coralline Oolite.	Middle Oolite.
Coral rag.		
Lower Calcareous grit.		
Oxford clay and Kelloways rock.	Oxford Clay.	
Cornbrash.	Forest Marble.	Lower Oolite.
Forest marble.		
Bradford clay.		
Great, or Bath Oolite.	Great Oolite.	
Stonesfield slate.		
Collyweston slate.		
Northampton sands.		
Upper Fuller's earth.	Fuller's earth.	
Fuller's earth-rock.		
Lower Fuller's earth.		
Inferior Oolite.		
Lias junction-sands.	Lias.	
Upper Lias clay, or shale.		
Marlstone.		
Lower Lias clay, shale, and limestone.		
Westbury beds (or white limestone).	Koessen beds.	Trias.
Bone-bed.		
Red marl and Upper Keuper sandstone.	Keuper.	
Lower Keuper sandstone.		
Marl (waterstones).		
Muschelkalk, absent in Britain.		
St. Cassian beds.		
Dolomitic conglomerate (Somerset and Gloucestershire).		
Upper red and mottled sandstone.	Bunter.	
Pebble beds.		
Lower red and mottled sandstone.		
Upper red marl.	Zechstein.	Permian.
Upper magnesian limestone.		
Lower red marl.		
Lower magnesian limestone.		
Red marl, sandstone.	Rothliegende.	
Breccia and		
Conglomerate.		

Upper coal-measures.	Coal-measures.	Upper Carboniferous.
Middle coal-measures.		
Pennant grit.		
Lower coal-measures.		
Gannister beds.		
Millstone grit (farewell rk.)		
Upper limestone shale (Yoredale rocks).	Carboniferous Limestone.	Lower Carboniferous.
Carboniferous (or mountain) limestone.		
Lower limestone shale.		
Upper Devonian and Petherwin limestone.	Devonian.	Old Red Sandstone.
Middle Devonian limestone and cornstones.		
Lower Devonian.		
Tilestone.	Ludlow beds.	Upper Silurian.
Upper Ludlow.		
Aymestry limestone.		
Lower Ludlow.		
Wenlock limestone.	Wenlock beds.	
Wenlock shale, sandstone and flags.		
Woolhope limestone.		
Denbighshire grits, shales, slates, and flags.		
Tarannon shale (or pale slates).	Llandovery.	
Upper Llandovery rock (May Hill sandstones) (Pentamerus beds).		

Lower Llandovery rock.		Lower Silurian.
Caradoc or Bala beds.		
Upper Llandeilo flags and limestones.	Llandeilo group.	
Tremadoc slates.		
Lingula beds.		
Harlech grits, etc.	Cambrian.	Cambrian.
Purple slates and grits (St. David's).		
Llanberis grits and slates.		
Longmynd rocks.		
Red sandstone, conglomerate of Scotland.		
Gneiss of the Lewis		Laurentian.
Basalt.		Rocks in masses, chiefly crystalline and eruptive.
Hornblende rock.		
Porphyry.		
Felstone.		
Trappean rock (Devon and Cornwall).		
Diallage.		
Hypersthene rocks.		
Serpentine.		
Elvan dykes.		
Greenstone (Diorite).		
Ashy slate, and Felspathic ash.		
Syenite.		
Granite.		

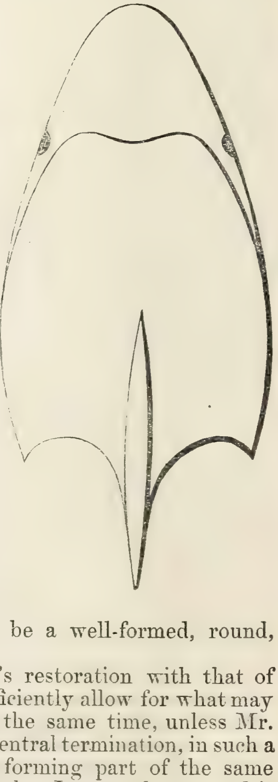
Scotch System of Carboniferous Rocks.

Upper coal-measures	=	Equivalent to British middle coal-measures, Pennant grit, lower coal-measures.
Moor rock	=	Millstone grit (Farewell rock).
Upper limestones Edge-coals series Lower limestones	=	Upper limestone shale (Yoredale rocks), Carboniferous limestone.
Sandstones, shales, and Burdie House limestone	=	Lower limestone shale.

Note on Pteraspis.—Sir,—I hope you will allow the following remarks, occasioned by the notices of Pteraspis in the 'Geologist' for November, December, and January last, a place in an early number.

In the spring of 1861, from amongst a lot of fragments laid aside by the workmen in a quarry in the hill immediately to the north of the Bridge of Allan, I picked up a fine head of *Cephalaspis Lyelli* and two tolerably complete heads of Pteraspis; and since that time I have, from the same place, procured another less perfect specimen of the latter genus. To this discovery I referred in a paper read to the Geological Society of London in July of the same year; and thus, I believe, I was the first to show that our Scottish rocks containing Cephalaspis also possessed the nearly allied genus Pteraspis.

Of the most perfect of these three heads, both the cast and its opposite have been saved, and are now in my possession. Although the matrix in which they have been preserved is so very coarse that the various layers composing the cephalic shield are not sufficiently preserved to show their characteristic structure, and hence Professor Huxley failed to identify my specimens with any of the named English species, yet its form is very perfectly exhibited; and in the cast, the spine which proceeded from the posterior part of the head is well shown. The rough sketch I herewith give is a tolerably correct representation, and is of the size of nature; from this it will be seen that it much more nearly coincides with Professor Huxley's restoration than with that of Mr. Mitchell. The head-plate had evidently been formed of two parts, the anterior resembling in shape the head of a small Cephalaspis, but rather more elongated; the posterior portion is by much the larger of the two, its length being nearly two and a half times that of the anterior; its shape is nearly oval, truncated behind, with a short cusp or horn on each side, and in the centre stretching backwards and upwards, terminating in a sharply pointed spike or spine. A very distinctly incurved ridge, but of no great elevation, commences about halfway back on the posterior plate, and terminates in the abovementioned spine. There are indications at the edges of the head, very close to the junction of the two plates, of what may have been the eye orbits, but these are indistinct. The principal if not the only points of divergence betwixt the specimen and Professor Huxley's restoration are, the position of the lateral terminal cusps, and the absence of any division betwixt these and the head-plate, and in the form and size of the posterior elongation (nuchal spine), which in my specimen seems to be a well-formed, round, sharply pointed spine.



Mr. Lankester, in comparing Mr. Mitchell's restoration with that of Professor Huxley, does not, in my opinion, sufficiently allow for what may have been specific differences of form; but at the same time, unless Mr. Mitchell finds what he figures as the prolonged central termination, in such a position as to afford undoubted evidence of its forming part of the same head, its size seems to me so sadly exaggerated that I cannot but regard it as having formed part of some other, probably very different creature. What renders this the more likely is, that I have examined many fragments which, although too imperfect to found on for any new genus, seem to belong to some nearly allied form, and are evidently parts of neither Cephalaspis nor Pteraspis. I am also much inclined to suspect that Mr. Mitchell's third figure has been built up of such fragments. Several heads of Cephalaspis which have been in my hands, go far to show that the larger part of the under portion of this fish's head had been covered by integument; and judging from the many points in which Cephalaspis resembles the Sturgeon of our own seas, I have little doubt but that, like it, it was furnished with a sucking apparatus for its mouth; and in all probability the under portion of the head of Pteraspis was similarly formed.

From these remarks, it must not be supposed that I wish, in any way, to detract from Mr. Mitchell's merits as an observer,—he is one of the most indefatigable as well as intelligent workers in that interesting field, the Forfarshire Old Red Sandstone; besides, not having seen his specimens, it would be unfair to speak too decidedly as to the correctness of the restorations. Mr. Mitchell has omitted to mention the locality from whence his specimens have been procured, so that the position of the containing rock might be ascertained. I have, however, little doubt but that this occupies the same horizon as that at Bridge of Allan, and that hence his Pteraspis is, in all probability, specifically the same as those in my possession. JAMES POWRIE.

Reswallie, January 23rd, 1863.

EAST COAST OF CHINA.—The geology of this region was described by Mr. F. W. Kingsmill, in a paper read before the Geological Society of Dublin during the past year, and is printed in the last number of the 'Dublin Quarterly Journal.' Commencing with the igneous rocks, there stretches, from the neighbourhood of the island of Hainan, N.N.E., to the Chusan Archipelago, a range of low granite mountains, from a few hundred to three thousand feet high, and in breadth from twelve to thirty miles. These hills form, for the most part, the coast-line, seldom receding more than a few miles inland. This granite, wherever it occurs, is deeply disintegrated, sometimes to a depth of one or two hundred feet; whilst everywhere embedded in the soft, yielding matrix, there occur nodules of more quartzose character, which have resisted the effects of time and chemical change. The masses are usually of a lozenge shape, and vary in size from a few feet to several hundred. The original quartz veins, broken into fragments, still traverse the disintegrated mass; whilst in the enclosed nodules concentric structure can generally be traced. In the higher grounds, the soft, yielding matrix has generally been removed by denudation, leaving those pseudo-boulders perched all over the granite hills, and presenting an aspect not unlike the boulder-formations of more northern latitudes. These have led, the author says, to an error in Professor Ansted's 'Elementary Treatise'—namely, that the southern limit of the glacial drift reached as far as Macao.

In the Quan-si, west of Canton, a gneissose rock is described. Resting on the granite occurs a stratified formation, most likely of Silurian age. It may be seen to advantage in the island of Hongkong. Over this is found a red sandstone, in some parts running into conglomerate. At the entrance to the West River (See-kiang) there is a dark, fine-grained, aluminous schist, much used for ink-stones and carved work. Over this red sandstone is the great limestone formation of China—the representative, probably, of the carboniferous limestone. In Quan-si it contains veins of graphite. Near Peking, at Lu-sud-twang, occurs a bluish-yellow slate, of so fissile a character as to be used for covering houses. The coal-measures succeed the limestone, the lowest member being apparently a micaceous sandstone, interstratified, near Peking, with compact ironstone and beds of ironstone. The coal-beds there are spoken of as overlaid by compact limestone. In the province of Chu-kiang a coal district also occurs, the measures probably being continuous; in this case, the Chinese coal-fields may prove to be the largest in the world, and at a future period will have an important influence on the destinies of the East.

The author knew of no formations of later date than the coal-measures, with the exception of the alluvial deposits in the great plains and perhaps some Secondary rocks in the island of Hainan. These plains occupy the greater part of China, and are everywhere intersected with canals and dykes, and seldom rise to more than a few feet over the medium level. From the mouths of the Yang-tze to the walls of Peking, along the Grand Canal, there scarcely occurs a rising ground, and the soil is so soft and muddy that it has been all but impossible to form a carriage-road in the British settlement of Shanghai.

In a general view of the geology of China, the country would appear to be divided into two districts, one consisting of the provinces of Quantung, Quang-si, and the southern portions of Yunnan, the other of the northern portions of Yunnan and the provinces lying northwards. They appear to be divided by the range of mountains running W. and E. through Yunnan, and terminating eastward in the Me-ling range, across which the road from Canton to Hankow passes at a considerable elevation. South of this line the rocks appear to be more of the metamorphic character, and to contain little if any coal, whilst to the north they are much less altered, and contain abundant stores of mineral fuel.

ERRATUM.—In the editor's article on Archæopteryx, p. 6, for "Miocene Rocks of Bonn, as well as in Braunkohl, near Aix," read "Miocene rock near Aix, as well as in the Braunkohl of Bonn."

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

GEOLOGICAL SOCIETY.—*January 7th.*—"On the Lower Carboniferous Brachiopoda of Nova Scotia." By T. Davidson, Esq., F.R.S., F.G.S.

The age of these beds was first clearly determined by Sir C. Lyell, and the author proceeded to point out the affinities of the entire Carboniferous formation to the Permian, and observed that many species, especially of Brachiopoda, are common to both formations. He combated the idea of a universal extinction of species at the close of the Palæozoic epoch, on the ground that some Palæozoic species pass upwards into Mesozoic strata; and then, after remarking upon the vagueness of the term 'species,' proceeded to show that science was not yet in a condition to enable us to test satisfactorily, by observation, the value of Mr. Darwin's theory of descent with modification. Mr. Davidson then remarked that the Lower Carboniferous Brachiopoda of Nova Scotia were smaller than the same or representative species occurring in contemporaneous strata in other parts of the world; and he concluded by giving diagnoses of the species determined by him, and comparing his list of species with that given by Sir C. Lyell in his 'Travels in North America.'

2. "On the Gravels and other superficial Deposits of Ludlow, Hereford, and Skipton." By T. Curley, Esq., C.E., F.G.S.

In describing some plans and sections taken during the progress of drainage-works in Ludlow, Hereford, and Skipton, the author mentioned the existence, near Ludlow, of two kinds of gravel, having a difference of level of about 100 feet, described three terraces of a like nature, about 30 or 40 feet apart vertically, in the vicinity of Hereford, and then noticed similar deposits near Skipton. Mr. Curley considers the majority of these gravel-beds to be of lacustrine origin.

MANCHESTER GEOLOGICAL SOCIETY.—*November 26th.*—An account was given of the excursion to Halifax, Hipperholme, Lightcliffe, and Low Moor, on the 3rd of September, with the Geological Society of the West Riding of Yorkshire, by E. W. Binney, Esq., F.R.S., V.P. The Natural History Society's Museum, at Halifax, was visited. It contains the finest examples of *Goniatites*, *Nautilus*, *Orthoceras*, and *Aviculopecten*, from the Lower Coal-measures. These specimens were chiefly obtained from the calcareous nodules, known as "baum pots," found in the roof-shale of the "hard bed" of coal, which has been extensively worked in the neighbourhood. There is also a good collection of fossil coal plants. Swan Banks Colliery was next visited. The "soft" and "hard" beds are wrought there. The former, 1 foot 5 inches thick, lies about 45 yards above the "rough rock"—the Upper Millstone of Professor Phillips and the Geological Survey. Twenty-six yards above the last-named seam is the "hard bed," nearly 2 feet in thickness, with a thin Gannister floor, round calcareous nodules or bullions in the seam of coal itself, and black shales, containing the "baum pots," in the roof. The geological position, characters of the coal and its adjoining strata, as well as the fossil shells, all tend to show that this seam is the same as the bullion mine of the Burnley district, and the Gannister mine of Dulesgate, Todmorden. The lower mine, containing beds of *Anthracosia* under its floor, probably occupies the same geological position as the Bassy or Salts Mine of the Bury and New Mills districts. Besides these two seams there are several smaller ones which are not worked; and on the top of the hill the lower part of the Elland flagstone, the equivalent of the Upper or Upholland flags of Lancashire, is seen; so this series of coals lies between the rough rock and the upper flagstone, and is identical with that part of the lower called Rochdale series of coals in Lancashire.

Mr. Richardson's unrivalled collection of fossil plants from the Yorkshire coal-field was next inspected; then the flagstone quarries of Hipperholme and South Owram, where flags of 4 and 5 yards square were being lifted. These stones, under the name of Yorkshire flags, are known all over England. The party now started by rail to Low Moor.

The Low Moor Iron Company's works were visited, as were also the mines. The lower, or "better bed," is a coal of most excellent quality, but only about 16 inches in thickness. It is exclusively used for making coke to smelt the iron-ore. The "black bed," from 30 to 35 inches in thickness, lies some 40 yards above it; but it is very inferior in quality: over it are about 4 inches of clay-band ironstone, in 4 or 5 layers, dispersed through 4 feet 6 inches of black shale. Besides the "black bed," an ironstone, known by the name of the "white bed," and lying some distance above the former, is used.

The position of the Low Moor seams of coal and their accompanying ironstones, is immediately above the Halifax series of coals and its overlying bed of flagstone, as seen at South Owram; strata not well developed in the Lancashire coal-field, although there represented near Heywood, between the upper flag deposit and the Arley or Dogshaw Mine.

The composition of the ironstone differs little from the ordinary clay-ironstones of the Yorkshire and Derbyshire Coal-measures, certainly not so much as to account for the price and quality of the iron made from the former, when compared with that made from the latter; it is therefore evident that the chief cause is the superiority of the iron produced.

An opinion was expressed by members of both Societies that it was desirable more of such mutual meetings should be held. Meetings might be held at Settle, to examine the bone-caves; at Ingleton, to inspect the Permian deposits of West-house, the coal-field of Black Burton, the mountain limestone and Silurian beds of Thornton Gill, and the dykes of Chapel-le-Dale; at Hazelhead, to examine the Lower Coal-measures seen between Dunford Bridge and Penistone.

Mr. Joseph Goodwin read a paper "On the Long-wall *versus* Pillar-and-Stall System of getting Coals." Much has been said upon the relative merits of the two systems of working coal; but all must be agreed as to the importance of adopting the system that will admit of the greatest percentage of "round" or "hand-filled" coal, and the greatest yield per acre, whilst affording to the workman the greatest security from accident, and the capitalist from losing his property. To say that any one system possesses all these much-to-be-desired advantages, under all circumstances, is more than could be affirmed. That the long-wall system possesses advantages over the pillar-and-stall, under some circumstances, is an indisputable fact; while, on the other hand, it is simply impossible to work some mines to advantage upon the long-wall system, however skilfully the workings may be conducted. Perhaps the most important advantage in the long-wall system is, that all the coal may be worked out without the slightest waste; this cannot be said of any other. If we consider this loss or waste in a national point of view, it will not be of much less importance to the whole community or future generations than it is to the proprietors of mines who sustain a direct pecuniary loss; for although there may be no fear of the coal of the United Kingdom being exhausted for a couple of centuries,—and in the meantime substitutes may be discovered that will lessen its consumption, and render the nation much less dependent upon it than at present,—it, however, cannot have failed to have occurred to all who have carefully considered the subject, that before another century has passed over, coal will not only be far more difficult to work, owing to the increased depth at which it will have to be wrought, but that some of our existing coal-fields will have been worked out, and many others reduced to very narrow limits.

In working the coal upon a properly conducted system of long-wall working, where the mine is adapted for such system, there can be little doubt but that the risk of accidents from falls of roof is materially lessened. The author had never seen the slightest accident from such source, where the long-wall system has been practised. But the fact ought not to be overlooked that some mines are naturally more dangerous to work than others, and that the danger often increases in proportion as the thickness of the seam increases, assuming that all other circumstances remain the same, and that, as a rule, it is the thinnest seams that are worked upon the long-wall system. The ventilation is far more simple in long-wall working than in pillar-and-stall, besides which, the health of the workman is not so impaired by driving narrow or "strait" work, this being in a great measure dispensed with.

Another advantage for the long-wall system is that of being able to dispense with the necessarily large outlay consequent upon driving narrow work in a systematic manner preparatory to working back the pillars, and thus securing a return for the capital expended in the least possible time. The North of England may be considered as the parent of the pillar-and-stall system, but it is now more or less used in almost every coal-field in Great Britain as well as upon the Continent. If it possessed no advantages over the long-wall system, the mining engineers who adopt its use might reasonably be considered very prejudiced men. That epithet has been lavishly applied by some of the advocates of the long-wall system to those who continue the use of the pillar-and-stall system, forgetting that they lay themselves open to the very same charge by adhering too rigidly to that which they believe to be the best. The author had deemed it best to carefully examine into every circumstance connected with a mine before adopting any system, and after so doing, he would not say that he might not err in judgment. The pillar-and-stall system will admit of an almost unlimited quantity of coal being daily worked from the same area that would only admit of a very limited output if the long-wall system was used. With many this is an advantage that must weigh much in its favour; although he was not an advocate for raising very large quantities where a smaller quantity, with judicious management, would produce a better profit. With the pillar-and-stall system the workings may be conducted any reasonable distance upon the line of level, the only limits being the increased cost of conveying the coal to the pit's eye, and the difficulty of thoroughly ventilating the workings, owing to the increased drag or resistance that has to be met in conveying currents of air through long air-courses.

With the long-wall system the case is very different; for owing to the difficulty and expense of keeping good the wagon- and air-roads, the distance is practically limited in many mines to a few hundred yards. The greatest distance on the line of level known to be worked out upon the long-wall system is rather more than 800 yards.

Where there are numerous faults, it is difficult to work a mine to advantage upon the pillar-and-stall system, but it is still more difficult upon the long-wall system; but the former system can be used under some circumstances where it would almost be impossible to work upon the long-wall system.

The quantity of timber that is used is not materially different whether the coal be worked on the long-wall, or pillar-and-stall systems, providing equal skill is displayed in laying out the workings, etc. While the cost of getting depends so much upon circumstances that it is unsafe to hazard an opinion in favour of either system, unless both have been employed in the same mine, under very similar circumstances,—and even in cases where that course has been adopted—the results have been sometimes in favour of the pillar-and-stall system, and at others *vice versâ*. It may be that occasionally some other system will answer better than either of the systems under consideration, for we by no means embrace the whole of the systems of getting coal when we speak of the pillar-and-stall and long-wall, although many of the methods of working coal are but modifications of either one or the other.

Mr. Binney said: "No doubt there will be more advocates for the pillar-and-stall system in Lancashire than for the long-wall. If the Lancashire gentlemen went into North Derbyshire, probably they would find a great many advocates of the long-wall system, and they would see advantages there which they do not see in Lancashire. The same remark will apply to the East of Scotland. The different systems of long-wall and pillar-and-stall workings would have different advantages in particular districts. In Derbyshire, where the long-wall system has been going on for 150 or 200 years, the men are so thoroughly drilled to it, and work it so scientifically, that its results would hardly be fair as applied to Lancashire, where it would take a long time to get men to work so well at it as they do in Derbyshire. On the other hand, there would be a like difficulty in introducing the pillar-and-stall system into Derbyshire.

PHILOSOPHICAL SOCIETY, MANCHESTER.—*January* 13.—Mr. E. W. Binney, the President, said:—In a very valuable work lately published by that eminent geologist Dr. Geinitz, of Dresden, entitled 'Dyas, or the Magnesian Limestone Formation and the Lower New Red Sandstone,' the author, whom he had the pleasure of accompanying over some of the Permian deposits of South Lancashire, had done him the honour to allude to two papers of his, 'On the Permian Deposits of the North-west of England,' printed in vols. xii. and xiv., second series, of the Society's Memoirs.

At page 313 of the above work, Dr. Geinitz says : " Through Mr. Binney we have become acquainted with true Rothliegende, and indeed of its upper portion in the region of the Lower Red Sandstone of the north-west of England. That accurate observer mentioned to me that the reddish-grey sandstone underlying it, and which is very similar to the Lower Red Sandstone of the north-east of England, contains plants of the Coal-measures, and that it occupies even a lower position than certain limestones of the coal-measures which are rich in ichthyolites. I have myself seen from the reddish sandstone of Astley, near Manchester, *Calamites approximatus*, Schl., and *Calamites Suckowi*, Brongn. ; from the red shales at Ardwick, Manchester, *Sagenaria dichotoma*, Sternb., *Calamites Suckowi*, Brong., *Sphenopteris irregularis*, Sternb., *Sphenopteris coralloides*, Gutb., *Dictyopteris neuropteroides*, Gutb., *Cyatheites villosus*, Brong., *Cyatheites oreopteroides*, Göpp., and *Alethopteris lonchitides*, Sternb., all true coal plants."

No one more than the learned author, Mr. Binney said he was sure, would like any mistake to be corrected. Now in the statement that " the reddish-grey sandstone underlying it (the true Rothliegende), and which is very similar to the Lower Red Sandstone of the north-east of England, contains plants of the coal-measures," the Doctor is quite correct; but when he proceeds to state " that it (the true Rothliegende) occupies even a lower position than certain limestones of the coal-measures which are rich in ichthyolites," that author had misunderstood him, and had apparently confounded the ribbon-beds of limestone in the red marls lying above the pebbly beds at Astley with the Upper Carboniferous limestones at Ardwick, and then stating that such pebble-beds occupy an inferior position to the latter. It is certain that the Astley pebble-beds containing coal plants occupy a higher geological position than the red shales, which, the Doctor truly states, also contain true coal plants. How much higher it is impossible to say, as it is most probable there are higher Carboniferous strata than those yet seen at Ardwick, and there may be Permian strata lower than those up to this time met with at Astley—at present we cannot tell.

As the Permian group of strata is now occupying the attention of geologists both in England and on the Continent, the following table of the beds in the north-west of England, with their approximate thicknesses, as seen at Shawk, west of Carlisle, Westhouse, south of Kirkby Lonsdale, and Manchester, in the descending order, may be acceptable :—

	Shawk.	Westhouse.	Manchester.
	Feet.	Feet.	Feet.
1.*Laminated and fine-grained red sandstones.	300	Not seen.	Not seen.
2. Red and variegated marls, containing sometimes, but not always, beds of limestone and gypsum, with fossil shells of the genera *Schizodus*, *Bakevellia*, etc. . .	150	Traces of them seen.	300
3. Conglomerate	4	300	50
4. Lower New Red Sandstone, generally soft and incoherent	7	500	500
5. Red shaly clays	Not seen.	250	Not seen.
6. Astley pebble-beds, containing common coal plants, termed by me Lower Permian .	Not seen.	Not seen.	60

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* The first four strata of the above series, Professor Harkness, F.R.S., in a fine natural section seen at Hilton Beck, north of Brough, estimates to be of 3000 feet in thickness.

In reference to the age of the New South Wales coal-field, Mr. Edward Hull stated that he had received letters from the Rev. W. B. Clarke, who has for many years been engaged in its exploration, and from Mr. John Mackenzie, who has had considerable experience as a mining surveyor in Wigan and North Wales. It is well known that Mr. Clarke maintains the Palæozoic age of the carbonaceous deposits of New South Wales, in opposition to Professor M'Coy, who holds that they are of more recent formation (Mesozoic). As Professor M'Coy has never actually visited the New South Wales coal-field, and derives his information from cabinet specimens, men of science will probably prefer the evidence of one who has spent years in personally exploring and collecting from the beds themselves. In Mr. Clarke's memoir on the 'Recent Geological Discoveries in Australasia' (2nd edit.), the author defends his view of the Palæozoic age of the coal-bearing strata; and in the letter from Mr. Mackenzie, the writer gives the following series of fossiliferous strata *overlying* the coal and cannel belonging to the Hon. B. Russell, which, if correct (as there is every reason for supposing), ought to set the question at rest in favour of the true Carboniferous age of those coal-measures. He states, "In a pit above this coal are strata with *Fenestella, Stenopora, Orthonota costata, Spirifer, Producta, Terebratula,* etc. In a pit about 100 feet below the same coal, occur *Spirifer, Producta, Conularia,* and vegetable impressions; about 60 feet lower, *Spirifer, Terebratula, Pleurotomaria,* and *Stenoptera;* and similar shells, accompanied by vegetable remains, are stated to occur still lower." Mr. Mackenzie promises to send specimens of *Lepidodendron* and *Sigillaria* from the same beds.

REVIEWS.

Journal of Botany. London: Hardwicke. Feb. 1863.

It has been a matter of astonishment to us, that the science of Botany has had no Journal in this country for several years. At a time when Hooker's Journal had got thoroughly established, it was suddenly discontinued, in the belief that the Quarterly Proceedings of the Linnean Society would supply all that was needed, but these, although every way suited for the publication of members' papers, could never afford a medium of intercommunication amongst botanists throughout the country, and botanical papers that did not find their way to a learned society were either buried among zoological and other memoirs, or hid in agricultural or horticultural periodicals, where no botanist would expect to find them. It is then satisfactory to hear that simultaneously with our present number, a new 'Journal of Botany, British and Foreign,' will begin its life under the editorship of Dr. B. Seemann, F.L.S., F.G.S., etc., whose 'Botany of the Herald' and numerous systematic Papers have given him an eminent place among botanists, and whose 'Viti and the Vitians' has recently established him as a popular and entertaining writer. He is assisted by several eminent botanists, both at home and abroad. Surely, an undertaking that promises to be of such service to botany will meet with the speedy support of all lovers of a science so extensively studied and so deservedly popular.

We are gratified in hearing that the successful establishment of the 'Geologist' has been regarded as an encouragement for the present attempt to establish a similar valuable means of intercommunication amongst the members of one of the most extensively studied of our sister-sciences. We hope it will do well.

Rambles in Search of Wild Flowers. By Margaret Plues. London. 1863.

Spring-time is coming; the tender buds are already showing their first green tops; and soon the buttercups and primroses, on meadow and on road-bank, will catch the brighter sunshine and bind its rays in golden flowers. Truly the geologist may feel rejoicingly the coming return of Spring's verdant scenes, for is he not a naturalist of the present as well as of the past? In those "sweet flowers,"—sun-smiles caught and bound to earth,—"the oak-tree and the mountain pine" are lessons of to-day for him by which to read the great eventful past to which his mind incessantly reverts. "This world is full of beauty, like other worlds above;" and in the silent rocks, at least for him, are records of perished earthly scenes, grander if not as fair as those spread out around.

"Gather the Roses while you may;
Old Time is still a-flying;
And this same flower, which smiles to-day,
To-morrow will be dying."

Amongst the dead leaves that fell in the primæval forests of our old earth ages before the merry laugh of the maiden Eve was echoed by the warbling birds in Paradise, Nature had caught, and in her stony tomb had kept, some few faded flowers. Was it to tell us, who were to live in after-times, that the fields the great beasts tenanted, and whom we know now only by these dry and sapless bones, were steaming with fragrant perfume and gaily painted with living colours? Or was it to teach that solemner lesson, read alike in the ponderous mountain, the solid earth, and—

"In the Rose
In its bright array—
Hear'st thou what these buds disclose?
'PASSING AWAY.'"

Whoever rambles this coming Spring through "meadows green or upland lawn," through "wood or dingle," on "mountain-top" or "rugged heath" in search of wild flower, will be much the wiser, and very likely very much the happier, for having taken with them the charming bouquets of flowers, poesy, and scientific lore so elegantly culled by Miss Plues.

The Future; a Journal of Philosophical Research and Criticism, embracing the most interesting Results of Modern Discovery and Opinion in Cosmological, Antiquarian, and Ethnological Science. Edited by Luke Burke, Esq., F.E.S. 8vo. Trübner and Co. 1862.

Those of our readers who are fond of reading scientific subjects discussed in an open spirit, will be rejoiced to learn that the above periodical is again in existence, and will be regularly continued until further notice. The twenty-second number of the second volume, which is now before us, contains a spirited article on the battle in Section D, on the "great Hippocampus controversy," by the editor, who in a most eloquent and argumentative manner, whether we agree with him or not, attacks severally the dogmas propounded by Owen, Huxley, Rolleston, Flower, *et hoc genus omne.* To our geological readers, the second article on "The Primæval and Ancient World; or, the relative Epochs of Monumental History," will be more interesting. The author says: "The history of humanity, as revealed by its monuments, may be divided into eight great periods or eras, some of them of very long duration, and all presenting materials for subordinate stratification. These eras may be named, the Geologic, the Cromlech, the Cyclopean, the Pyramidal, the Eastern, the Classic, the Mediæval, and the Modern, the succession and contradistinction being very clearly indicated. The Geologic era may be considered as extending from the time of man's first appearance on this planet, until we meet with unequivocal vestiges of his civilized labours. During this long period, infantile humanity was gradually overspreading the earth, asserting its supremacy over inferior animals, and rehearsing the sad story of passion, conflict, and crime, which has been so often repeated in its subsequent annals. In certain more favoured centres, it was also slowly emerging from primal barbarism into incipient forms of civilization. This vast unknown space must doubtless cover its tens of thousands of years, and may hereafter have to be divided into several distinct epochs; but as yet it can scarcely be said to belong to archæology at all, so few are its known mementos, and so completely do these fall within the dominion of geology." It is perhaps needless to state that the sentiments advocated by Mr. Burke are of the most liberal character; and we trust full success may be achieved by this philosophical periodical, of which he is the energetic editor.

Science Elucidative of Scripture, and not Antagonistic to it.
By J. R. Young. London: Lockwood. 1863.

Mr. John Radford Young is a mathematician of eminence, and was formerly professor in Belfast College. He makes no pretensions to being either a geologist or a theologian; but he is a sensible man; and, as a mere layman, "fully sensible by his own incompetency to do complete justice to the cause he has undertaken," he steps in to take part in a discussion which is every day rising to greater dimensions, thinking, that "when attacks on the Bible have to be repelled" it is likely a volunteer in the service may receive more willing and candid attention than would be given to "one whose sacred office and bounden duty it avowedly is," as he swears in his ordination oath, to "drive away all erroneous and strange doctrines contrary to God's word." As to the points in dispute, whether the Bible and creation or the Bible and science are in accordance, we have always set our face against expressing an opinion. On other occasions we have invariably maintained that the time was not come for a systematic and proper comparison. We think so still. The Biblicists generally know nothing of geology, and not a tithe as much as they ought to do about that very book, for the accuracy of whose every syllable they so senselessly contend, and for the due fitting of whose every piece with every possible doctrine or fact they so strenuously labour. The anti-biblical geologists, on the other hand, are often quite as senseless in their opinions as their antagonists. Mr. Young is too acute a man not to perceive some of the weak points in accepted geological doctrines; and if he do not always know enough to attack them with complete success, the well-directed fire of his artillery and its destructive power upon some parts of the groundwork, even of modern geological tenets, shows that the battle is not yet half fought out, and that the war will last, at least, until science is rid of those visionary speculations which some of her votaries have worked into her fabric, and which, like the rotten materials of the dishonest contractor, or the incoherent walls put together by incapable workmen, endanger the whole edifice in case of attack. When Geology and Scripture are brought into opposition, outsiders would do well to ask, What is Geology, and what is Scripture? When we have both replies, we might judge, probably very rightly, that as in the case of all quarrels, both sides were wrong, or at least not right,—which is pretty nearly, although not quite the same thing. If the Scripturists will *à priori* state *what* the Bible declares in respect to creation, or if they will give us a *correct* reading only of what the Bible does say; and if the geologists will give us—if they can agree amongst themselves—a correct version of the ancient history of our earth, then the public can judge well enough whether the two versions do agree or whether they do not. Until this is done, we do not think arguments will be much more conclusive than they have been. "Everybody knows," Mr. Young says, "that physical hypotheses are by no means necessarily physical truths;" but in geology some of these hypotheses, "originally invented to group together natural phenomena under some assumed general principle, from which those phenomena may be logically deduced," have been commingled with theories or stated as facts.

It is but a few years since that we heard an eminent Fellow of the Geological Society say that the main work of geology was done, and geologists had only to arrange their materials and keep their collections in order. Since then we have had Sorby and others working at granites and metamorphosed rocks, and Darwin coming in with some stirring notions about the transmutation of species and the *imperfection* of the geological record. Latterly, too, the researches and speculations of Professors Thompson, Tyndall, and Haughton; the discoveries of Kirchhof and Bunsen; the experiments of Airy and Hawkins; and the progress made in chemistry, astronomy, physics, and all the other sciences, have made us feel, what is doubtless felt by every deep-thinking or observant mind, that the fabric of geology is not as solid as it ought to be, and the deductions from hypotheses or facts not always as satisfactory or as logical as one could wish them. It is only too true that there are matters of geology far more rickety than is quite pleasant to its defenders. "So long as geology lets the Bible alone it may go on constructing its theories as it pleases," says Mr. Young; but if these theories are paraded, in opposition to Scripture, as "geological truths, the grounds upon which they lay claim to this dignity must be examined." Whether this be correct, that geologists parade their doctrines in opposition to Scripture, or whether the outcry was not really raised by the opposite party against geologists, does not matter here. In both cases it is equally right that the doctrines of geologists should be submitted to as rigid tests as the words of the Bible. And so Mr. Young, as well as he is able, and sometimes ably, attacks the dogmas of geology. For example, giving in full the geologists' hypothetical assumption that the primary condition of the globe was a fluid molten mass, and the necessary corollaries of that assumption, that it has successively cooled down until a crust of aqueous deposits containing remains of their life-creations could be deposited from successive oceans, Mr. Young requests the reader to examine them, "and then, if he know anything of science in general, to ask himself if the fanciful scheme here depicted deserves to be called a strictly scientific theory. What is the primary assumption? Why, that the earth originally was a globe of fluid molten mass. Being a globe, all the parts of it equidistant from the centre must have been in the same condition; and when, by cooling, the outer crust had formed every part of that crust must have been (at least, as to thickness) in the same condition. Upon this crust the internal molten fluid exerted an expansive force (how it acquired this force is not stated) by which 'certain parts of it were pushed up,' while at the same time, or afterwards, certain other parts 'suffered a corresponding depression.' Is this consistent, that the same expansive force should push up and pull down—be at once propelling and tractile? And why, seeing the physical necessity of uniformity of condition of the whole, *all* the crust should not fare alike, is hard to conceive; and still harder is it to conceive that a piece of crust once up should go down again, or once down should go up again. Yet these alternate up-risings and down-sinkings, this game of geological see-saw, was not played out till twenty-eight or twenty-nine alternations had been gone through. But it must be admitted that though all parts of the crust had equal claim to rise or fall, yet the apparent want of fair play was, in the long run, equitably compensated; every part had its innings, and the very ground which the reader now occupies has bobbed up and down at least eight-and-twenty times! Such is the doctrine in all the books." "Observe, too, in the foregoing detail of operations, the sort of co-partnery in the work between God and Nature—the ingenious division of labour. The Creator supplies the raw material already in a molten state; Nature then takes it in hand, and shapes it and cools it, so as to fit the waters that surround it for marine tribes, which Deity forthwith supplies. Nature again steps in, and by upheavals presents to Omnipotence some dry land, 'compatible with the existence' of land-organisms, with which it is of course speedily furnished; and so on, as narrated above."

Now, in this comment, although there is much that is defective, some things not true, some apparently suppressed, and others exaggerated or caricatured, yet it really does hit well home, and the "internal heat doctrine" and "the cooling-down theory" receive rather severe handling.

The upheaval of one part of the earth's crust while another is depressed, and all elevations and down-throws of such masses, are readily accounted for by the *contraction* of the solid earth-shell *over* the internal fluid mass; but although one may "show cause why" such events or such phenomena *might* or could have happened, no one can handle these theories as weapons of defence against an acute antagonist without feeling their want of sharpness and temper. They may be correct, but it is certain they want proof and substantiation; and so long as geologists are content with fanciful hypotheses and illogical deductions, so long will they fail to wield those ponderous and irresistible arguments which this grand science is well able to furnish. This quotation will suffice to show that although Mr. Young's arguments may not be convincing, there is "food for reflection" in his writings.

His book is a small one, and cheap; the matter, probable as well as improbable, lively, interesting, dogmatic, speculative, argumentative, and clever; and is well worth perusal, although we do not think Mr. Young brings the subject a bit nearer a settlement than his predecessors have done, or than his followers are likely to do in our time. The more works of this kind, the better for the cause of truth. Each puts forward the boldest and most telling points of his opponents; and if he fail to demolish them, he helps his enemy's cause instead of his own, and readers get enlightened by the failure as surely as by the success.

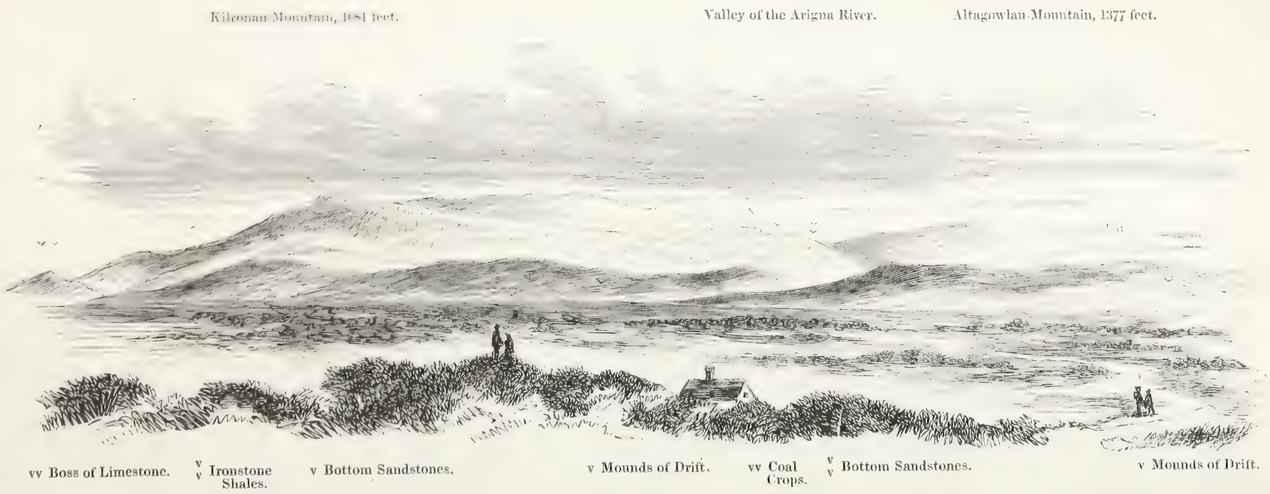
Cartes Géologique et Hydrologique de la Ville de Paris. By M. Delesse. Savy, 1861.

Rather more than a year ago, M. Delesse presented to the Geological Society of France two maps of the city of Paris, executed under the orders of M. le Baron G. E. Haussmann, Prefect of the Seine,—one a geological map of the subsoil of the city itself, as far as authorized actual excavations; the other hydrological, giving the quality and modes of flowing of the springs, especially of the subterranean watercourses. An ordinary geological map indicates only the rock found at the surface, but in the former of the maps the attempt is made to make known the nature as well as the form of the rocks which composed the under-soil. Such a labour is exceedingly difficult, and the more so that the rocks of Paris are remarkably varied; but the numerous works undertaken there of late years have offered unusual facilities for the comparison of sections.

The city of Paris is traversed by four superficial sheets of water—the Seine, the Bièvre, the stream of Ménilmontant, and the canal Saint-Martin. Independent of these, there exist the subterranean watercourses which are attained on the sinking of wells. These the hydrologic map shows in a very complete manner. The positions of these subterranean sheets are very interesting. There is pointed out, first, a subterranean sheet in immediate communication with the Seine, and designated the "infiltration-sheet" (*nappe d'infiltration*), which extends under Paris, and is that which furnishes the water of nearly all the wells. Its horizontal curves are undulating lines nearly parallel. They are disposed symmetrically on each side of the river, and accord with the superficial sheet. The level of the infiltration-sheet is generally above that of the Seine, and rises in proportion as it recedes from the banks of the river. Its form depends entirely on the river reproducing all its variations. Then the islands of Saint-Louis and Notre Dame are shown to have a distinct subterranean water-sheet, equally an "infiltration-sheet," with concentric horizontal curves nearly parallel with their contours; the sheet slightly elevated towards the central part, and inclining, on the other hand, towards the shores of the islands. Near the ancient barrier Blanche, some wells are fed by a subterranean sheet, of which the average is about 142 mètres. This sheet is above the lacustrine limestone, and is altogether distinct from the infiltration-sheet of the Seine. Near the ancient barriers Roche Chouart and Fontarabie, subterranean sheets are met with at an average of 137 mètres; these are also above the infiltration-sheet.

The map shows well the flowing of these subterranean courses. For example, in the infiltration-sheet of the Seine, which extends everywhere under Paris, it is seen that the water is necessarily directed from a higher to a lower point; and consequently, contrary to the ideas generally entertained, it inclines towards the shores of the stream. Thus, however paradoxical it may seem at first sight, the Seine plays, in respect to the subterranean sheet, the part of a draining canal; it determines the flowing of the water, and effects the drainage of the city.

PLATE V.


Kilronan Mountain, 1081 feet.
Valley of the Arigna River.
Altagowlan Mountain, 1377 feet.
vv Boss of Limestone.
v v Ironstone Shales.
v Bottom Sandstones.
v Mounds of Drift.
vv Coal Crops.
v v Bottom Sandstones.
v Mounds of Drift.

VIEW OF THE COAL-MEASURE MOUNTAINS, NORTH AND SOUTH OF THE ARIGNA VALLEY, LOOKING N.W.

From the Limestone on Road near Drumshambo, Co. Leitrim.

THE GEOLOGIST.

MARCH 1863.

ON THE BITUMINOUS COAL OF THE ARIGNA DISTRICT, COUNTIES OF ROSCOMMON AND LEITRIM.

By George V. Du Noyer, M.R.I.A.,

Senior Geologist, Geological Survey of Ireland.

"Why is it that there is no bituminous coal of any account in Ireland?" This is a question which I have often been asked by well-informed people, and the answer is comprised in the one descriptive

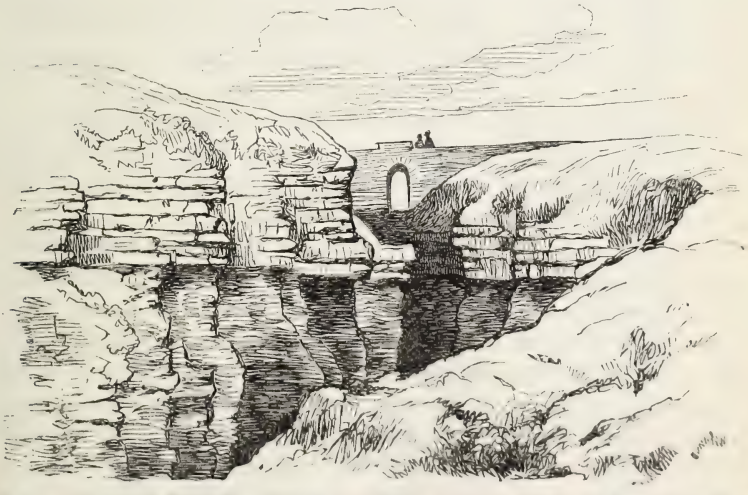


Fig. 1.—Junction of basal sandstones and black ironstone shales, on stream bounding the townlands of Tullymurry and Tullycorka, north-east base of Altagowlan mountain, County Leitrim.

word, "*Denudation.*" In truth, there is no reason why, at one period of our geological history, the great mass of the bituminous coal-bearing strata occurring in England should not have extended over what is now Ireland; but, strange to say, while this store of inestimable wealth was being preserved in England, and covered by the New Red Sandstone and probably Tertiary rocks, the adjoining portion of the earth's crust was being gradually raised from beneath the sea, and wellnigh effectually denuded of its carbonaceous covering. Ireland, therefore, for the most part, presents an older geological surface than England, especially over the areas now occupied by the Devonian and Carboniferous rocks; and I believe that all we have now remaining to us in the upper portion of the latter, is some of the basal beds of the English coal-measures, represented by three thin layers of bituminous coal, capping the mountains at either side of Lough Allen, in the counties of Roscommon and Leitrim, and extending into the Co. Sligo.

The most important coal-beds of the Arigna district, or those which are being worked at present, occur to the west of Lough Allen, and near the summits of the mountains of Kilronan and Altagowlan; the former being 1081 feet, and the latter 1377 feet above the sea, having the valley of the Arigna river between them.* From an examination of these coal-fields, which I made in the month of March, 1862, I am enabled to add some information to that which we already possess regarding them, which, I have no doubt, will be acceptable to those who are interested in the subject of the Irish bituminous coals.

The accompanying view of these mountains, taken from a boss of carboniferous limestone on the roadside near Drumshambo, on the way to the old Arigna iron-works, may convey some idea of the general aspect of the country. (See Plate V.)

The flat middle distance is occupied by the carboniferous limestone, the low ridge beyond, which rests on the S.E. flank of Kilronan Mount, is formed entirely of drift, derived from the disintegration of the local sandstones, dark grey grits, and black shales and ironstones of the coal-measures. The Arigna river passes through the gap in this ridge; to the extreme left of the view a boss of carboniferous limestone makes a feature in the landscape, and the slope of the hill above it, which is deeply intersected by small stream-courses, is composed of the black ironstone shales and dark grey flaggy grits of the basal coal-measures. Above this, and forming the rugged scaur on the brow of the mountain, are the "Bottom Sandstones," or seat-rock of the coals; above them are the two coal-beds; the "crops" of which are defined by the level surface of the underlying sandstones, at either side of the mountain.

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* The level of Lough Allen is 160 feet above the sea.

The summit is formed of sandstones, with dark grey shales, flaggy grits, and some nodular bands of clay ironstone (see Section).

The mountain to the extreme right is Altagowlan, and the two coal "crops" near its summit are clearly defined on its northern side, by the low precipitous faces of the sandstones with which the coals are associated.

By reference to the accompanying Sections, Nos. 1 and 2, the physical structure of both these mountains will be at once understood.

In order to afford a still clearer notion of the vast amount of denudation to which the whole of this district has been subjected, I give the subjoined diagrammatic section across it, from

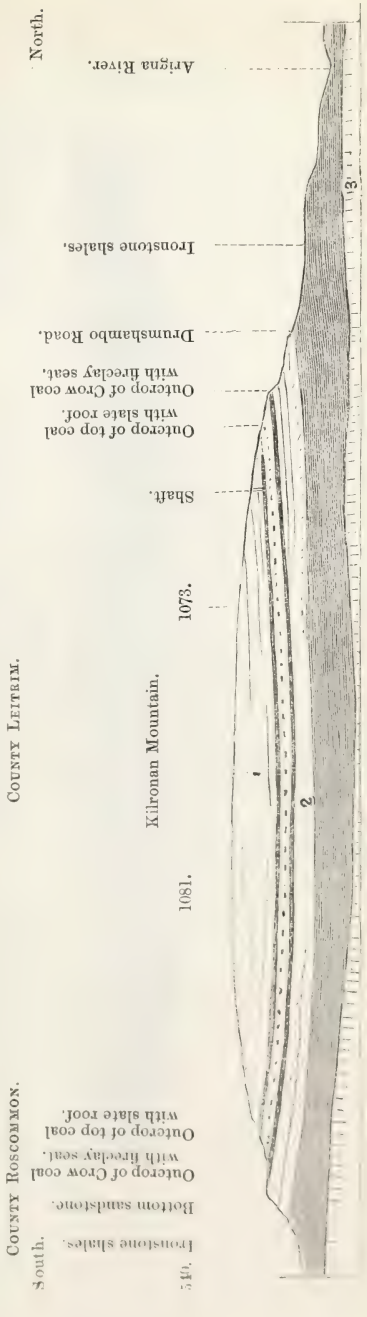


Fig. 2.—Section from S. to N. across the Townland of Rover.
1. Flaggy sandstone with black shales and ironstone nodules; 2. bottom sandstones; 3. Carboniferous Limestone.

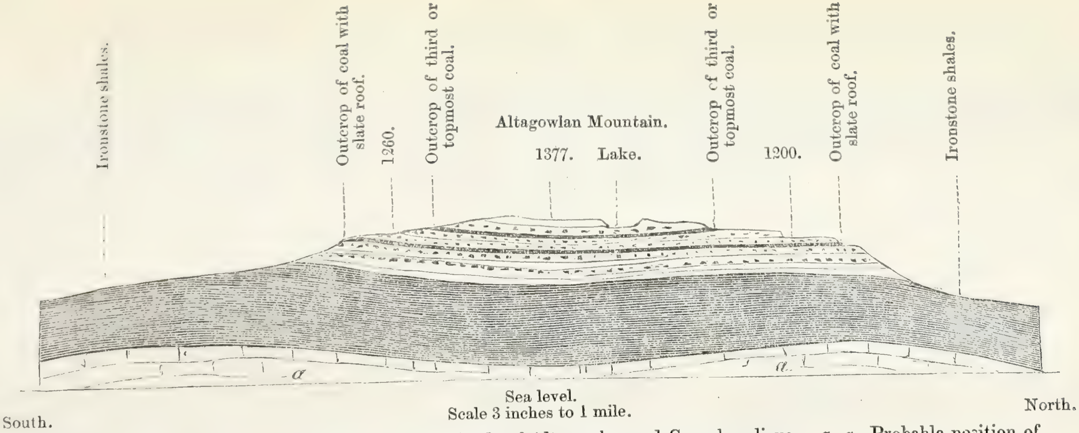

Ironstone shales.
Outcrop of coal with slate roof.
1260.
Outcrop of third or topmost coal.
Altagowlan Mountain.
1377.
Lake.
Outcrop of third or topmost coal.
1200.
Outcrop of coal with slate roof.
Ironstone shales.
a
a
South.
Sea level.
Scale 3 inches to 1 mile.
North.

Fig. 3.—Section from S. to N. through the townlands of Altagowlan and Greaghnaslieve. *a*, *a*, Probable position of Carboniferous Limestone.

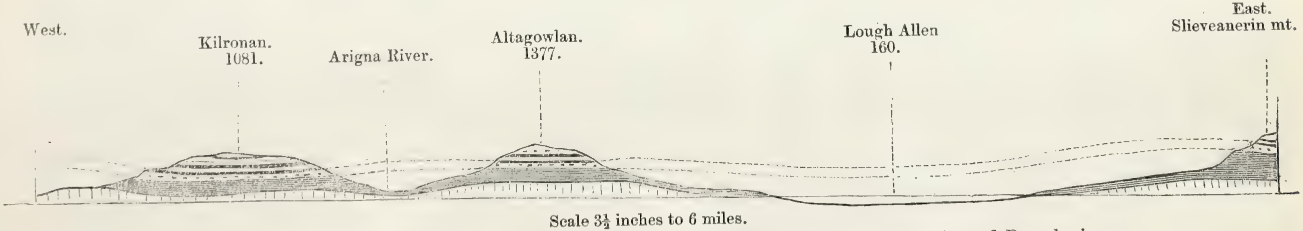
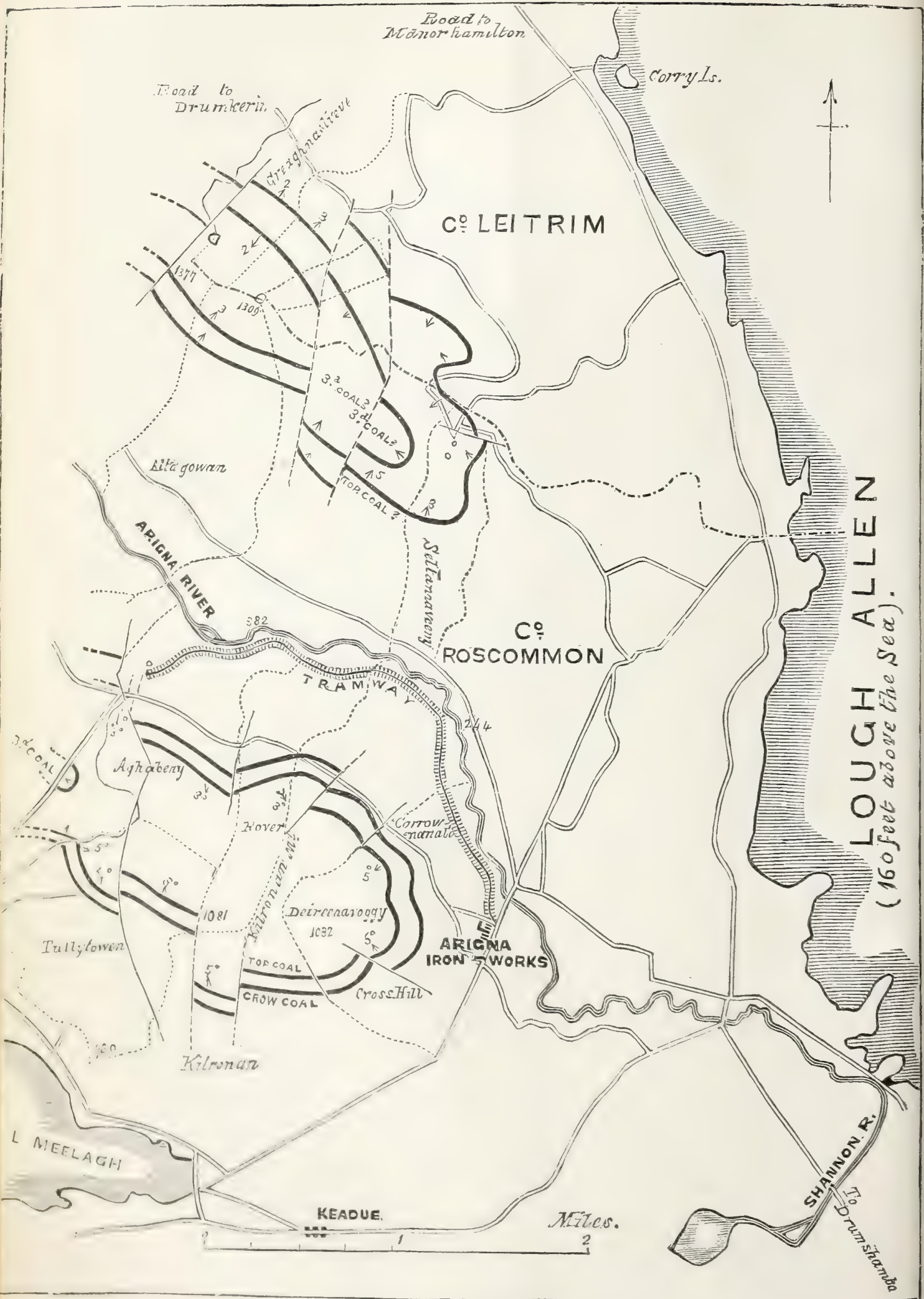


Fig. 4.—Diagrammatic Section across the Coal-measure Mountains between Drumshambo and Drumkerin.



MAP OF THE ARIGNA COAL FIELDS.

Illustrating Mr. Du Noyer's observations on the Bituminous Coal of the Counties Leitrim and Roscommon.

west to east, commencing at the limestone to the west of Kilronan Mount, and ending on the western side of Slieveanerin Mount, which rises to the east of Lough Allen, a distance of twelve miles.

From this it will be very apparent that a little more denudation, and the coal-beds which cap the mountains would have been removed.

In the year 1788, a speculation, under the name of the Arigna Company, was set on foot to smelt the iron ores of the district around Lough Allen, and operations were commenced by erecting extensive smelting furnaces on the south bank of the Arigna river, within a mile and a half of Lough Allen and three and a half miles from Drumshambo. The coals were procured from the pits at Aghabehy and Rover, and a tramway of nearly three miles in length was constructed to facilitate their transit to the works, from the former and more distant colliery.

In the year 1818, Sir R. Griffith compiled a mining and geological report on the Connaught coal-fields, in which a rather too favourable opinion was expressed as to the thickness, extent, and quality of the coals; this he however subsequently modified.

In 1830, Mr. Twiss made a report on the Arigna ironstones, for the directors of the Arigna Company, in which he speaks in the highest terms as to the quality of the ore, the amount of which he regards as inexhaustible. After a trial, extending over a period of about thirty-five years, the Arigna Company failed, and this serious mishap to a most legitimate mining undertaking forms a prominent feature in the history of Irish stock-jobbing speculations.

In 1838, the Railway Commissioners' Report on the Connaught Coal-fields appeared, and it is therein stated that the total area occupied by coal covers 20,000 acres, representing a bulk of 20,000,000 of tons. At present the coals raised from the old pits in the Arigna district are only sufficient to supply the mere local market, and have been estimated by Sir R. Kane, in his 'Industrial Resources of Ireland,' to be about 3000 tons annually. With regard to the Kilronan and Altagowlan coal-fields, so far as I can judge, I see little prospect of their being properly developed, chiefly from the apparent exacting spirit evinced by the owners of the royalties, based upon an exaggerated notion as to the extent and bulk of the coals, and ignorance as to the difficulty of procuring them.

The total extent of the coal-beds in this district and that which lies to the west of it, stretching into the Bralieve range of mountains, is about 5 miles from N.W. to S.E., with an average width of about 1 mile at Kilronan mountain, which forms the eastern termination of that long narrow coal-measure basin. The Altagowlan basin, on the opposite side of the Arigna valley, may be about 3 miles, from N.W. to S.E., with a width of three-quarters of a mile. In these areas there are but three beds of workable coal, the thickest of which is not over 2 feet 6 inches, and one of the beds has its roof and floor of hard sandstone. See "upper coal seam of Creughnaslieve."

The following is Sir R. Griffith's section of the Kilronan Mount coal-measures, taken from his 'Mining Report on the Connaught Coal-fields,' and its general accuracy is undoubted:—

Strata.	Feet.	SURFACE.
18	30 to 50	Sandstone flags.
17	30 to 60	Blackish-grey sandstones and gritty slate.
16	100 to 200	Slate clay, in beds of variable thickness and hardness, and containing innumerable beds of clay ironstone.
15	COAL.	Third or upper seam, 8 to 9 inches thick (?).
14	24 to 45	White sandstone.
13	10 to 15	Grey soft slate clay. Coal roof.
12	COAL.	Second coal, 2 ft. 6 in. to 3 ft. 4 in. (Over-estimated.)
11	12 to 15	Sandstone.
10	6 to 15	Black slate clay.
9	4 to 20	Greyish-white sandstone.
8	COAL.	Third or "Crow" coal, intermingled with clay laminæ, 1 to 3 feet. (Over-estimated.)
7	1 to 3	Fire clay. Coal seat. (Over-estimated.)
6	1 to 3	Sandstone, with plant impressions. (Often much thicker.)
5	6 to 10	Grey (and very hard) sandstone.
4	9 to 20	Black slate clay (shale).
3	30 to 60	Greyish-white sandstone, known as the first or bottom sandstone.*
2	300 to 600	Black slate clay, with grey flags, and innumerable ironstone nodular layers and beds, varying from half an inch to 2 feet in thickness.†
1		Carboniferous limestone, unknown. Page 20 of Report.

As my examination of these coals was confined to the Arigna district, and had distinct reference to those places where *coal* is now being raised, I shall limit my remarks to the facts which came under my own observation, as by so doing I shall afford some aid to future explorers in this most interesting and important field of research, and I cannot prejudice the question as to the advisability of these beds being worked as a profitable mining speculation.

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* Upwards of 250 feet thick at Altagowlan, and close on 200 feet on the south-east flank of Kilronan.

† Upwards of 800 feet at Altagowlan mountain.

I traced the outcrop of the two coal-beds around the entire northern, eastern, and southern limit of Kilronan Mount; devoting my attention specially to those which appear in the townlands of Aghabehy, Tullytawen, and Rover, and in those of Carrownaualt, Derreenavoggy, and Cross Hill, on the eastern brow of the mountain. On the other side of the Arigna valley I examined particularly the coal "crops" in the townlands of Greghnaslieve, Tullytawen, and Seltennaveeny, without however having had time to connect them accurately over the intervening spaces. Their position as indicated on the map, and the faults disturbing them, will not, however, be very far from the truth.

The following observations are extracted from my field notes :—

1. *The Aghabehy Coal-field.*—This lies on the northern slope of Kilronan mountain, at an elevation of 510 to 899 feet above the level of Lough Allen, from which it is distant about six miles by the road ; there is here but *one* bed of workable coal, called "the top coal," 1 foot 6 inches in thickness, which includes 6 to 8 inches for holing. The roof of this coal is slate, and the floor sandstone. The second, or lower coal, or "crow coal," is separated from the first by 20 to 55 feet of very hard sandstone; it has a thin fire-clay seat with a sandstone or "rock" roof; and is 6 to 8 inches thick, it is full of thin seams of earth, and yields only culm of an inferior quality. The culm derived from the "holings"* of the top seam is very superior, and cokes well. Blocks of a light, flaky, and glistening coal, measuring 8 to 10½ inches in thickness, are now being delivered at the pit-mouth, at the cost of 5*s*. 6*d*. a ton, including the culm ; a ready sale is effected for this at 10*s*. per ton for thick and screened coal, and 8*s*. per ton for the culm, giving however to every ton of culm 4 cwt. of the thick coal. When struck with the hammer, I remarked that these blocks of coal shivered throughout their bulk, which induced me to suppose that they would not bear any rough treatment in their transit over long distances.

From the northern outcrop of the "top coal" in the N.W. portion of the townland of Aghabehy, and at the stream near the road, a fault has been proved, causing a downthrow to the west of about 100 feet ; it strikes from this point South by East to the shafts near the top of the hill, a distance of about 850 yards, or half a mile. From this point I believe it strikes S.S.E. into the adjoining lowland of Tullytawen, for the distance of three-quarters of a mile to near the farmhouses of the latter townland, when I think it will be found to strike S.S.E., and with that bearing to leave the district.

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* The term "holing" is applied to that portion of the bottom of the coal-seam which, in the absence of a Fire clay "seat," is picked away by the miner in order to extract the coal above in blocks. In this instance, the refuse makes excellent culm.

It is a somewhat remarkable fact, that on the eastern side of the fault just alluded to, the coals have never been accurately proved or their outcrop defined, with the exception of a small space east of the shafts, at the distance of one-third of a mile above the chisel-pit.

The townland of Tullytawen lies to the south of Aghabehy, on the southern slope of the mountain, and is traversed by the Aghabehy fault, which cuts off the coals by a downthrow to the west. I was informed that the "top coal" here measures 1 foot 6 inches in thickness, with a *fire-clay seat of* 3 *inches.* The "crow coal" is stated to be here 6 inches thick. Considerable workings have, for many years back, been made in the "top coal" at this locality; but as at Aghabehy no record was kept of the amount of coals extracted, and as the workings were on the pillar-and-stall plan, no sooner was the coal extracted than the roof and floor were allowed to collapse, and thus to obliterate all traces of the works.

The "top coal" has been rather extensively worked, at the townland of Rover, which joins Aghabehy on the east.

In the townlands of Carrownanult, Darreenavoggy, and Cross Hill, the outcrops of the two coals is very well seen. The top seam is, however, by all reliable accounts, lessening in thickness at this portion of the coal-field, and is only 12 inches thick, while the crow coal is only 6 inches; here we find that the basal sandstones are thickening, while the coal is thinning. It is just as probable, however, that in the Western portion of the coal-field of Kilronan or that which extends into the Co. Sligo, the coal may thicken and improve in quality. Around the circuit of the eastern termination of Kilronan Mount, the coal-measures are traversed by at least six faults radiating from the centre of the hill; of these the most considerable occurs in the south-west portion of the townland of Kilronan mountain, but owing to the flatness of the beds, which dip often as low as 3°, a slight dislocation in their continuity would throw a coal crop hundreds of yards out of its line of strike. The faults therefore which occur to the east of that at Aghabehy would be of no importance in the event of the coals being worked, as their direction and throws could be most accurately determined and calculated.

2. *The Greaghnaslieve and Altagowlan Coal-fields.*—This area, which appears to afford the most valuable coals in the district, lies

at an elevation of between 710 and 1209 feet above the level of Lough Allen, from which it is distant about three miles; a most excellent road leads from the lake to within 400 yards of the outcrop of the bottom seam of coal. The lower coal has here a slate roof, from which fact, I should suppose that it corresponded to the top coal of Aghabehy, and the upper coal here would therefore agree with the thin seam, numbered 15 in Sir R. Griffith's section, and which is thinly developed in the district to the west of Kilronan mountain. Though this may be probable, I am aware that it is unsafe to attempt to identify coal-seams merely from a correspondence in their "roof" or "seat. At the outcrop of the lower coal, along the northern brow of this mountain, the strata are clearly seen to have a slight dip away from the hill, or to the north-east. This is explained in the Section No. 3, which shows that this portion of the coal-measures forms the northern side of a low anticlinal, the prolongation of which to the north has been cut off by the denudation; by tracing these beds, however, up the mountain, they are found, as a mass, to be bent synclinally and to form a shallow basin. The *rise* therefore of the coal to the hill, on its northern flank, which causes the beds to be self-draining, will, in all probability, be found to cease in the distance of 250 yards.

The lower coal-seam of Greaghnaslieve afforded the following section on the northern face of the mountain:—

Seat rock, sandstone.

Holing 6 to 8 inches in brown sandy clay, and slightly micaceous shale, answering to an impure fire-clay.

Fire-clay coal, or fire-clay, with numerous bituminous layers and strings through it, 8 to 10 inches.

Coal from 1 foot 4 to 1 foot 6.

Roof, black slate clay, 7 to 10 feet.

Rock roof, sandstone.

In my table of thickness, etc., of the coals, I have called this the two-foot coal.

The upper coal seam, or that nearest to the top of the mountain, was not as well exposed as the lower. I traced its outcrop across the townland, but had not an opportunity of examining it closely. I was informed, however, that it is of equal thickness with the lower seam, but it wanted the shale holing, and its roof and floor is sandstone or "rock;" we may therefore value it as an 18-inch coal.

From the inaccessible nature of the ground in the townland of Altagowlan, and its proximity to that of Greaghnaslieve, it is evident that the whole of this coal-bearing area should be worked from the northern side of the mountain. I believe that the quality of the Greaghnaslieve coal is the same as that from the Seltanaveeny Pits.

3. *The Seltanaveeny Coal-field.*—Extensive operations have been carried on here for many years back in the northern part of this townland, adjoining that of Tullynahaw, and shafts to the depth of 120 feet have been sunk in the coal; from the comparatively low position of this ground and the fact that this portion of the coal-field is formed by the stream S.E. end of the Altagowlan basin, and the coal at its outcrop dips to the hill in every direction, great difficulty will ever be experienced in freeing the workings of water. (See map.)

The distance to the lake from those pits is four miles, by the new road to Greaghnaslieve, or two and half by the old and at present broken-up road leading from Tullynahaw colliery.

The subjoined is my estimate of—

THE THICKNESS, AREA, AND WEIGHT OF COALS IN THE FOLLOWING TOWNLANDS, FORMING PORTION OF THE ARIGNA COAL-FIELDS, COUNTY ROSCOMMON.

	Townlands.	ft.	in.	Acres.	Tons.
	North-west Coal-field.				
	Greaghnaslieve, lower seam	2	0	100	200,000
	Greaghnaslieve, upper seam	1	9	60	95,000
	Altagowlan, lower seam	2	0	94	188,000
	Altagowlan, upper seam	1	9	42	73,500
				296	556,500
	South-west Coal-field.				
Top coal.	Aghabehy, proved area	1	6	36	54,000
	Aghabehy, unproved area	1	6	133	199,000
	Tullytawen, proved area	1	6	18	27,000
	Tullytawen, unproved area	1	6	67	100,000
	Rover, partly proved	1	6	120	180,000
				468	561,000
	South-east Coal-field.				
	Carrownanalt	1	0	179	179,000
	Derreenavoggy				
	Crosshill				
				179	179,000
	North-east Coal-field.				
	Saltanaveeny, available	2	0	72	144,000
				72	144,000

In the accompanying table certain townlands are given which form only detached portions of the two great coal-fields.

As it may interest some of our readers, I subjoin the analysis of the Arigna coals, and that of the ironstones, as given in that valuable work on the 'Industrial Resources of Ireland,' by Sir Robert Kane (second edition, p. 23):—

"*Aghabehy Coal.*—A rich black coal, easily broken. Specific gravity, 1·274. When heated, it gives off a good deal of inflammable gas, and leaves a light, porous, grey, coherent coke. Analysed in this way, it was found to give, from 100 parts:—

Volatile matter	23·10
Pure coke	66·15
Ashes	10·75
	100·00

"One part of this coal reduced twenty-six parts of lead to the metallic state; one hundred parts of it, therefore, represented seventy-seven parts of pure carbon.

"*Celtanaveeny and Meenashama Coal.*—Specific gravity, 1·290.

	Seltanaveeny.	Meenashama.
Volatile matter	19·10	18·90
Pure coke	65·87	61·46
Ashes	15·03	19·64
	100·00	100·00

"*Rover Coal.*—Specific gravity, 1·287.

Volatile matter	17·70
Pure coke	74·89
Ashes	7·41
	100·00

"One part of it gave by ignition with litharge 28·4 parts of lead; hence one hundred parts of the coal corresponded to eighty-four of pure carbon.

"The actual elemental composition of Aghabehy and Rover coals was found to be as follows:—

	Aghabehy.	Rover.
Carbon	79·69	81·04
Hydrogen	6·24	4·91
Oxygen	3·52	6·64
Ashes	10·75	7·41
	100·00	100·00

" *Clay Ironstone Nodules from Arigna.*—Mean of five analyses:—

Protoxide of iron	51·36
Lime	1·59
Magnesia	1·92
Alumina	0·98
Insoluble clay	12·82
Carbonic acid	31·33
	100·00

And this contains 40 per cent. of metallic iron.

"The loss by calcining, the iron remaining as protoxide, should be in average 31·33 per cent.; and the calcined ore should consist of 100 parts of

Iron	58·2
Oxygen	16·6
Lime and magnesia	5·1
Clay	20·1
	100·00"

(See Sir R. Kane's 'Industrial Resources of Ireland,' p. 136.)

CORRESPONDENCE.

Crocodilian Remains in the Scottish "Old Red."

Sir,—Observing that the report of a Scottish crocodile having been found in the Old Red Sandstones of Morayshire has been commented on in your Notes and Queries for February, I think it right to state that no reptilian remains have been recovered from any of the sandstones of that county, of whatever age, with the exception of those of the well-known Telerpeton, Stagonolepis, and Hyperodapedon.

The stone containing the first of these, the *Telerpeton Elginense*, was got from a quarry near the Loch of Spynie, some two to three miles south of Elgin, by the late Mr. Patrick Duff, and is now in my possession. It is described and figured by the late Dr. Mantell (Jan., 1852), in a paper contained in the eighth volume of the 'Geological Journal,' as a small lacertian reptile, about four and a half inches in length.

The *Stagonolepis Robertsoni* has been long known, and was so named by Agassiz, and is by him described, in the 'Poiss. Foss. du Vieux Grès Rouge,' as a ganoid fish. The discovery of many fragments of bones since has enabled Professor Huxley to fix the true nature of these remains. The Stagonolepis is described by him, in the fifteenth volume of the 'Geological Journal' (1858), as a reptile having considerable affinities to the crocodile, and as having reached from 16 to 18 feet in length. Many remains of bones and scutes belonging to this creature have been found in a quarry at Lossiemouth, some five miles south of Elgin, and are preserved in different museums, as in that of Elgin, the Museum of the Royal School of Mines in Jermyn Street, etc.

The remains of *Hyperodapedon Gordoni* were got from the same quarry which affords those of Stagonolepis, by the Rev. G. Gordon, of Birnie, and is noticed in a note to a paper on the sandstones of Elgin by Sir Roderick Murchison, also published in the fifteenth volume of the 'Geological Journal.' It is supposed to have been a Saurian reptile, of from 6 to 8 feet in length.

Besides these, numerous slates covered with reptilian footprints are from time to time dug from the neighbouring quarries of Cummingstone.

The sandstones containing these remains were originally believed to belong to the upper division of the Old Red Sandstone series, and are described as such by Sir R. Murchison in the paper above referred to. In the note to that paper, however, it is remarked that, in consequence of the high organization of these reptiles, and their affinity to those found in Mesozoic strata, and as the stratigraphical relation of these sandstones with the undoubted Old Red Sandstones of Elgin cannot, from overlying soil, be positively determined, there is considerable reason to suppose that they may belong to a more modern epoch; and since that time they have been looked on by most geologists as Triassic. The question of age has again been opened up lately by the discovery of footprints similar to those of Cummingstone in sandstones, believed to be Old Red, in Ross-shire. At present it would premature to give any opinion as to the true position of these reptiliferous sandstones; but, as this is being very carefully wrought out by well-qualified parties, it is to be hoped that a short time will suffice finally to set at rest this *quæstio vexata*. JAS. POWRIE, F.G.S.

Reswallie, February 12, 1863.

Analysis of Red Chalk.

DEAR SIR,—The article on the above subject, by R. Calvert Clapham, Esq., in the 'Geologist' for January, 1863, p. 29, will no doubt have been read with pleasure by geologists taking interest in such matters, more especially those who study the chemical properties of the two strata mentioned in the article above alluded to. At the same time I beg to refer Mr. Calvert Clapham to a paper on the Red Chalk of England, by the Rev. T. Wiltshire, in the 'Geologist' for 1859, p. 161. In speaking of the analysis of the Red Chalks of Speeton and Hunstanton, Mr. Wiltshire states that "one of the members of the committee of the Geologists' Association, Mr. Rickard, has been good enough to make me an analysis.

"The Speeton is as follows:—

Carbonate of lime, with a little alumina	81·2
Peroxide of iron	4·3
Silica	14·5
	100

From Hunstanton—

Carbonate of lime	82·3
Peroxide of iron	6·4
Silica	11·3
	100

The above results of Mr. Rickard are nearly the same as those produced by Mr. Calvert Clapham. The latter gentleman seems to have paid more minute attention to the minor contents of the substances analysed.

Mr. Calvert Clapham states that "at Speeton it (the Red Chalk) is in some places a soft red clay, and is used to colour bricks and red pottery." Whenever the Red Chalk is found soft, like clay, at Speeton, it is because of its being displaced from its original bed and ground to a powder by large masses of white chalk which overlie the red chalk, falling upon it, and then the rains falling upon, or small streamlets passing through it, give it the consistency of "soft red clay;" but it is not to be found in a soft clayey state *in situ.* I must beg respectfully to state, that Mr. C. Calvert is labouring under a mistake, when he states that the red chalk is used at Speeton for colouring either bricks or rough pottery: it is not so used; but an article very much the same in colour is used, viz. Venetian red, a sample of which I enclose for your inspection, and remain,

Your obedient servant,
Edw. Tindall.

Mammalian and Human Remains, Isle of Portland.

Sir,—Will you allow me to send you some remarks relating to an account, in the 'Times' of the 1st of January last, of some human and other bones which have been discovered associated together in fissures of the rock of Portland Island, during the building of the fortifications there?

The following is the passage in the 'Times:'—"The sections of the wonderful geological strata which form the Island of Portland are seen for the first time, in the straight rocky walls of the ditch, in all their curious variety. What is most singular is, that at regular intervals of twenty-five or thirty yards, and commencing about twenty feet below the surface of the ground, are a series of vertical faults or gaps, about two feet wide, which, as far as can be judged, penetrate to the lowest substrata of the island, and traverse it completely from north to south. In these extraordinary clefts, human bones have been found, with those of wild boars and horns of reindeer, not fossilized, but with all their osseous structure as perfect as if they were not fifty years old."

In 'Willis's Current Notes' for August, 1852, there is a nearly similar account of human and other bones found in the fissures of the Portland rock. The account says:—"It appears that in the year 1844, some human bones were discovered on the ledges of a fissure in a quarry belonging to Mr. Weston, at different depths, from twenty-five to forty feet. These fissures run parallel with each other throughout the island, from north-east to south-west, at stated distances, varying from forty-five to sixty feet, and the quarrymen say that they always know when they are coming near to them from the form the upper layers of loose stone and rubble assume, losing their longitudinal stratification, and having all the appearance of having been dragged out of their position by a mighty rush of water from above into the fissure. These fissures do not extend to the surface-soil by five or ten feet, and run down to the blue clay, through the several strata of stone, etc., to the depth of from eighty to a hundred feet, having many ledges or shelves in them, and generally covered with stalactitic formations. On several of these ledges a number of bones of all kinds of animals were found, including those of the human species. These were preserved and shown by Captain Manning to the late Rev. Dr. Buckland, on his next visit to the Castle; but the doctor having doubts as to the place where they were found, accompanied Captain Manning to the fissure, where a lad was let down who brought up more of the bones in his presence.

Professor Buckland stated as his opinion, that the mass of matter of which the Island of Portland is composed on drying cracked and so formed these fissures. But how is it these fissures did not extend up to the surface-soil, where the evaporation must have been greatest, and where there appears no trace of them? Several teeth and a tusk of an elephant have recently been discovered in the dirt-bed of the Portland quarries."

The truth of these facts mentioned in the 'Current Notes,' which, in all material circumstances, are similar to the facts mentioned in the 'Times,' has been confirmed to me by Captain Manning himself, who has several times shown me, at Portland Castle, human and other bones, and amongst them those of the elephant, which have been discovered in the fissures of the Portland rock. Captain Manning stated that these fissures did not extend to the surface of the rock.

The truth of these geological facts may be easily ascertained by any person visiting Portland Island.

If human and other bones have been found in fissures which have no communication with the surface of the earth and are covered with solid stone, must they not have entered the rock before its consolidation, and, consequently, when it formed part of the bed of the sea? And must not, therefore, the men and animals to whom the remains belonged have inhabited some other dry land, which probably no longer exists? And does not this render probable the opinion of M. Cuvier, expressed in the following words:—"I conclude, with MM. De Luc and Dolomieu, that if there be any fact well established in geology it is this, that the surface of our globe has suffered a great and sudden revolution, the period of which cannot be dated further back than five or six thousand years. This revolution has, on one hand, engulfed and caused to disappear the countries formerly inhabited by men and the animal species at present best known; and, on the other, has laid bare the bed of the last ocean, thus converting its channel into the present habitable earth"?

The period of this revolution, which MM. Cuvier, De Luc, and Dolomieu believe to have been effected by an interchange of land and sea, synchronizes very nearly with the one usually assigned to the Mosaic Deluge. Your obedient servant,

Thos. D. Allen.

Rectory, North Cerney, Cirencester, Jan. 23, 1863.

Glyptolepis—Dura Den.

Dear Sir,—The Rev. Mr. Mitchell, in his communication regarding this genus in your number for February, omits to mention that the discovery that what formerly used to be named *Holoptychius Flemingi* is in reality a species of Glyptolepis, is by no means quite new.

The attention of Professor Huxley, Mr. Robert Walker, of St. Andrew's, and myself, having been directed to the Dura Den fishes, in consequence of rather extensive excavations in the Den, which, through the kindness of Mrs. Dalgleish, were allowed to be made in the summer of 1861, for furnishing specimens to the St. Andrew's Museum, we seem independently to have arrived at that conclusion. Towards the end of last summer, in writing me, of date 24th September, 1862, Mr. Walker states, "What was rather a curious coincidence," etc., "I left the Museum with a pretty strong conviction that the scales of *Holoptychius Flemingi* and Glyptolepis appeared to be one and the same, when here comes your letter to strengthen that conviction." (I had just written him to that effect.) Mr. Walker has, undoubtedly, the merit of first making this discovery public; this he did in an admirbale paper, describing most accurately this species, *H. Flemingi*, and stating his conviction that it belonged to the genus Glyptolepis. This paper was read on, I think, the 22nd of November last, before a meeting of the Literary and Philosophical Society of St. Andrew's, and has since been published in the 'Annals and Magazine of Natural History.'

Not only must the *Holoptychius Flemingi* hereafter be looked on as belonging to the genus Glyptolepis, but it seems to me exceedingly probable, that Holoptychius may ere long be altogether merged into that genus. The only species of Holoptychius on which I have never yet been able to detect scales, showing the crescent of points on the anterior half so characteristic of those of Glyptolepis, is *H. Andersoni*, and this I am at present inclined to think not a good species at all. Of *Holoptychius giganteus*, the only good specimen I have yet examined is the superb one in the collection of Lady Kinnaird; of this it is the ventral surface which is exposed, and on the anterior portion the scales show very distinctly the characteristic markings of the *Holoptychius giganteus* of Agassiz; along the flanks on both sides they as clearly assume the Glyptolepis character, in many instances showing the crescent of points so distinctly as to be readily observed by the unaided eye, while towards the tail the scales assume the exact appearance of those on *Holoptychius Andersoni;* indeed, so exactly does this fish resemble *H. Andersoni* in form, in the comparative size and disposition of the scales, in the position, structure, and form of the fins, so far as preserved, in the comparative size and form of the head and jugular plates, indeed in everything except size, that I am much inclined to think *H. Andersoni* the young of *H. giganteus*, increased age developing the different sculpturing on the scales. Mr. Walker refers in his paper to a very imperfect specimen of this fish in the St. Andrew's Museum, the scales along the flanks also showing the crescent of points on the anterior half, the others resembling those of *H. giganteus*. Mr. Walker also pointed out to me what I fully concur with him in thinking a species, nearly allied to, but distinct from *H. Flemingi*, with which it seems hitherto to have been confounded, and in this every scale sufficiently preserved appears to have the crescent of points as in Glyptolepis. In a specimen now in my possession, which was obtained by the late Mr. P. Duff of Elgin, from the Bishop Mill (Elgin) sandstones, and which has been named, I think correctly, *nobilissimus;* I have also been able to detect one scale having the crescent of points well preserved, and I am informed by Professor Huxley, that the typical specimens of *Holopt. Sedgwickii*, in the Cambridge Museum, present unmistakable Glyptolepis scales.

Mr. Mitchell mentions a Paper communicated by me to the Geological Society of London, and published in their Journal for November last, in which I first drew attention to the occurrence of Glyptolepis scales in the Dura Den Sandstones, and in which I notice a fish as a new species of Glyptolepis. This fish, however, I now believe to belong to some other, probably new genus, the caudal and other fins, as well as the general form too little resembling Glyptolepis, while of the scales it is only the internal structure which is shown, and although on one or two the external sculpturing is imperfectly preserved, yet the body where these are situated being a good deal twisted, they may have belonged to some of the many other fishes scattered over the flag on which this is preserved.

Thus at present stands the case Holoptychius *versus* Glyptolepis; it is, however, being carefully wrought out, and as Mrs. Dalgleish has most generously consented to allow still further excavations in the Den, I have little doubt but that this question will be decided during the course of next summer.

Yours, etc.,

James Powrie, F.G.S.

Roswallie, February 18*th*, 1863.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society.—*January* 21*st*.—1. "On a Northerly Extension of the Upper Silurian 'Passage-beds' to Linley, Salop." By Messrs. George E. Roberts and John Randall.

Sections obtained along the course of Linley Brook, near Bridgenorth, Salop, were shown to exhibit an ascending series of deposits from Aymestry shales, through Upper Ludlow rock, Downton sandstones (with bone-bed), grey shales and grits (with bone-bed), and plant-bearing shales, to Old Red clays. The lower bone-bed was stated to be chiefly composed of scales of Thelodus and broken Lingulæ, and the higher one to contain a more than usual abundance of fish-spines; and it was remarked that crustacean remains were altogether absent, but *Lingula cornea* had a range upwards to the Old Red clay. The authors considered the physical conditions of the period to be those indicated by Sir Roderick Murchison in his remarks upon the change in the character of the sediments which closed the Silurian epoch. The occurrence at Trimpley, and elsewhere, of a cornstone-band in the plant-bearing shales, was noted as giving a more defined basis for the Old Red Sandstone.

2. "On some Crustacean-tracks from the Old Red Sandstone near Ludlow." By George E. Roberts, Esq.

Tracks of a crustacean found by Mr. Alfred Marston on a thin sandstone layer, lying between two bands of cornstone at Bouldon, seven miles north of Ludlow, were exhibited by the author, and doubtfully referred to Hymenocharis. The sandstone in question was stated to be rich in crustacean and annelidan tracks and trails. The lower cornstone in the section exhibited at Bouldon was referred to the horizon of the plant-bearing shales of Linley.

3. "On the Parallel Roads of Glen Roy, and their place in the History of the Glacial Period." By Professor T. F. Jamieson.

After describing the general appearance of the roads, the author referred to the different theories that have been framed to account for them, giving his reasons for considering both the marine hypotheses untenable, and pointing out the evidences in favour of Agassiz' theory of a dam of glacier-ice having supported a freshwater lake. He especially dwelt upon the coincidence between the height of each of the parallel roads and that of a neighbouring watershed, but also remarked upon the objections to a glacial barrier, explaining how it might have shrunk at three successive periods, so as to allow of the formation of the three roads. He then showed that the period of the formation of these roads must either have been posterior to that of the submergence during the Drift period, or that the sea did not reach them during the submergence; also, that it was prior to the formation of the forty-feet raised beach of Argyleshire.

Professor Jamieson concluded by stating that his examination of Lochaber had led him to infer that the parallel roads are the beaches of ancient freshwater lakes, which arose from glaciers damming the mouths of the valleys and reversing their drainage, at a date subsequent to that of the great land-glaciation of Scotland, owing to a re-extension of the glaciers after the chief submergence of the Drift period.

February 4th.—1. "On a Hyæna-den at Wookey Hole, near Wells."—No. II. By W. Boyd Dawkins, Esq., B.A., F.G.S., of the Geological Survey of Great Britain.

The former but partial exploration of this cave by the author convinced him of the desirability of a more rigorous examination, the details of which were given in this paper, with a Table of the species of Mammalia whose remains were met with, showing the distribution of the teeth and bones in the several parts of the cave, and also a statement of the general results arrived at. A consideration of the distribution of the remains in the cavern and their close juxtaposition to the roof, coupled with the fact that the flint and chert implements discovered were found in much lower positions, led Mr. Dawkins to infer that the bones had been dragged in by hyænas, and that the cave had been subjected to periodical inundations of waters laden with red mud, whereby the bones had been elevated by degrees until they occupied their present position. After a detailed description of the bones, the author concluded by some general remarks upon the bearing of this cave-fauna upon the ancient physical geography of the district, and the antiquity of the associated implements of human manufacture.

2. "On the discovery of Paradoxides in Britain." By J. W. Salter, Esq., F.G.S., of the Geological Survey of Great Britain.

A short sojourn in the neighbourhood of St. David's enabled Mr. Salter to discover, at Porth-rhaw, near Whitchurch, on the St. David's road, a gigantic Trilobite belonging to a genus which has been long sought for in the British Isles. The author gave a short description of the geological features of the locality, and a section showing the succession of beds belonging to the Primordial Zone in Wales, as well as a diagnosis of the newly-discovered Trilobite, which he named *Paradoxides Davidi.*

3. "On the Fossil Echinidæ of Malta." By Thomas Wright, M.D., F.G.S. With Notes on the Miocene Beds of the Island, by A. Leith Adams, A.M., M.B. (22nd Regiment.)

The Echinoderms, described in this paper by Dr. Wright, were discovered by Dr. Leith Adams, during a careful examination of the strata and geological features of Malta. A description of the miocene beds was given by the latter gentleman, in which he stated his reasons for not accepting entirely the classification of them proposed by Captain Spratt, and followed by Earl Ducie in his Geological Map of the Maltese Islands. He divided the miocene strata into the following subdivisions:—1. The Upper Limestone; 2. The Sand Bed; 3. The Marl; 4. The Calcareous Sandstone; 5. The Lower Limestone; and again subdivided the Upper Limestone into three parts. Dr. Wright gave a diagnosis and detailed description of forty species of Echinidæ, eighteen of which are new; and Dr. Adams added a Table showing their stratigraphical distribution.

February 20th.—The anniversary meeting at Somerset House was rather thinly attended. The obituary notices included the names of Trench, Leonhard, Rev. J. Cumming, Bronn, Bertrand de Doue, J. C. Nesbit, and the Marquis of Breadalbane. The Wollaston gold medal was awarded to Prof. Gustav Bischoff, of Bonn, for his work on Chemical Geology; the Wollaston fund to Professor Senft, of Eisenach, to assist him in his labours in the classification of rocks. "His work on that subject," the president remarked, "was of high esteem in Germany, and would no doubt be held so in this country when it was known here." The presidential address consisted of details of the lines of stratigraphical and palæontological discordances, and the horizons of unconformability in the Palæozoic group of rocks. Professor Ramsay said that it had been a practice with previous presidents to review the chief geological results of the past year in the anniversary address, but want of time had precluded his doing so, and he had therefore selected a special topic, the first part of which he now read to the meeting, and the continuation of which he would complete on the next like occasion.

In the debate on the official annual report, Mr. Charlesworth, in a speech of more than an hour's duration, drew the attention of the Fellows to systematic breakings of the fundamental rules of the society's charter by the council, and to various other subjects in which he thought that improvement might be made. He said it was a scandal to the society, with their large funds and competent income, to have advertised for a paid secretary who had the responsible duties of the care of a valuable collection and the editing of the most important publications, and to offer a salary of £200 a year, without lodging or perquisites, while even the local institutions of Bristol and York paid £250, with residences in their buildings. He said that the recent election of the present assistant-secretary by the council had been illegally done, and referred to passages in the charter as distinctly stating that the election should be made by the *Fellows* themselves; and, when some members of the council objected that the council were empowered to elect an assistant-secretary by virtue of a bye-law delegating such a power to them, Mr. Charlesworth replied by quoting other passages from the charter, "that no bye-laws could be made at variance to the rules of the charter," and he contended that therefore any such bye-law must be not only objectionable but absolutely void in law, and that any Fellow choosing to do so could, by an injunction of the Court of Queen's Bench, set aside the election altogether. He also complained that the minute-book had not been laid on the table in accordance with the rules of the society. Mr. Warington Smyth asked Mr. Charlesworth whether he wished the time of the society to be taken up by the reading of the whole of the entries relative to the council meetings for the last six months, as over that period various notices relating to the appointment had been made. Mr. Charlesworth said he wished the names of the candidates only to be read. Mr. Warington Smyth then read an extract to the effect "that the report of the committee for the election of an assistant-secretary had been received by the council," and said that that minute did not contain the names of the candidates. In reply to Mr. Charlesworth, the president said he could not remember the names of the candidates. Information on this subject was thus avoided by the council. Mr. Charlesworth then drew attention to the state of the fossils in the museum, and stated the collection was, at least as far as the finer and more delicate fossils were concerned, in a worthless state. The specimens were in drawers and covered only with paper. He alluded particularly to the valuable collection of Crag fossils presented by Mr. Searles Wood—a collection that represented the labours of a life—and the finer specimens of which were absolutely destroyed. He proposed that the Society's collection should be reduced in quantity to one-fourth, and that fourth be displayed for practical purposes in glass cases.

The officers elected for the ensuing year are:—*President*—Professor A. C. Ramsay, F.R.S. *Vice-Presidents*—Sir P. G. Egerton, Bart., M.P., F.R.S. and L.S.; R. A. C. Godwin-Austen, Esq., F.R.S.; Leonard Horner, Esq., F.R.S.; Sir Charles Lyell, F.R.S. and L.S. *Secretaries*—William

J. Hamilton, Esq., F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S. *Foreign Secretary*—Hugh Falconer, M.D., F.R.S. *Treasurer*—Joseph Prestwich, Esq., F.R.S. *Council*—John J. Bigsby, M.D.; George Busk, Esq., F.R.S.; Robert Chambers, Esq., F.R.S.E. and L.S.; Sir P. G. Egerton, Bart., M.P., F.R.S.; John Evans, Esq., F.S.A.; Rev. Robert Everest; Hugh Falconer, M.D., F.R.S.; R. A. C. Godwin-Austen, Esq., F.R.S.; William John Hamilton, Esq., F.R.S.; Leonard Horner, Esq., F.R.S. L. and E.; Professor T. H. Huxley, F.R.S.; Sir Charles Lyell, F.R.S. and L.S.; Robert Mallet, Esq., C.E., F.R.S.; Edward Meryon, M.D.; John Carrick Moore, Esq., F.R.S.; Professor John Morris; Robert W. Mylne, Esq., F.R.S.; Joseph Prestwich, Esq., F.R.S.; Professor A. C. Ramsay, F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; Alfred Tylor, Esq., F.L.S.; Rev. Thomas Wiltshire, M.A.; S. P. Woodward, Esq. The members that retired from the Council were:—Sir Roderick Murchison; G. P. Scrope, Esq.; John Lubbock, Esq.; the Earl of Enniskillen; and Sir Charles Banbury.

MANCHESTER GEOLOGICAL SOCIETY.—*December 30th.*—"On the Carboniferous rocks of Shap and Crosby Ravensworth." By J. S. Bland, Esq. The rocks considered in this paper are a series of the Lower Carboniferous or mountain limestone, on the east side of the Lake Mountains in Westmoreland. These, it is well known, flank the old slate rocks of which the mountains are formed, on nearly all sides; but most regularly in the north-west, north, and north-east; running from Egremont by Brigham, Ireby, Greystoke, Lowther, Shap, Orton, to Ravenstonedale. Mr. Binney describes a portion, or section of this series, in the vicinity of Shap and Crosby Ravensworth, across to the New Red Sandstone in the neighbourhood of Appleby. The New Red Sandstone, in its turn, overlies the Carboniferous series, covering the whole of the north of Cumberland, from Maryport, around by Penrith, Ormside, to Kirkby Stephen, which is the extreme southern point it reaches. From there the line runs back by Brough, and the side of the Crossfell range, to Brampton, in Cumberland, and so northwards into Scotland.

About a mile from Shap Wells, are Wasdale Crags, the crest of a great mountain mass of porphyritic granite; flanking this, on the N. and N.E. sides, are the Lower Silurian, or green slate rocks; on the S. and S.E., are the Coniston series of flags, also considered as Lower Silurian, but of later formation; lying between these, is the Coniston limestone, described by Professor Sedgwick as running in an almost direct line from Ambleside. From the granite rocks northwards, across West Sleddale, the green slates occur; after which, as far north as Rosgill Moor, are a series of dark shaly slates, similar in character to the Skiddaw slates. In some beds Graptolites have been found by Professor Harkness. To the N. and W. again, are the green slate rocks; these, each in their position, are overlaid, unconformably by the Old Red Sandstone, or where it is wanting, by the Carboniferous series. These rocks, therefore, formed the dry land, against which the waves of the Old Red Sandstone sea made their last throws,—a wild and barren coast. The Old Red Sandstone, lying upon each of the different series enumerated, represents a coast-line, nearly at right angles to that of the Coniston group of deposits; consequently, a great change in the relative position of land and water must have taken place about the close of the Silurian era; of which, Shap granite has in this district been the disturbing power. The Old Red Sandstone from Shap Wells south to Tebay, is a considerable thickness of dark red sandstone, with conglomerates above. From Shap Wells, northwards, its position is indicated by conglomerate and red shales, evidently the deposits of an ancient shore; the best sections of it may be seen at the railway cutting at Shap summit. This cut, famous in the annals of railway engineering, is right through a hill of hard metamorphic green slate rock, which, when the Old Red Sandstone waters washed this coast, was a small peninsula or promontory of rock running out into the sea, presenting steep cliffs at low water, but nearly submerged by the higher tides. On each side of the hill, not quite to its summit, are the deposits of the old shore; first, at the bottom of the cliff, a true sandstone of only small thickness; after it, red shales and coarse conglomerates; higher still, the red colour disappears, and beds of fine gravel have been formed of the disintegrated slate and granite rocks from the neighbouring hills. This has been washed and tossed about by storms, into the crevices of the sea-cliffs, where it may now be seen, as regularly stratified as any other shingle on the coasts of the present day. This coast-line is not traceable further north. It is difficult to tell whether the upper beds of this old shore-line belong to the Old Red Sandstone, or the Carboniferous series; we may, however, admit it as marking the transition, and recording the fact, that at that time no commotion had disturbed the relative positions of land and water on this coast, such as marked the close of the Silurian era.

The first deposit in ascending order, is a limestone of considerable thickness; it is of three different characters, the lowest strata are of dun colour, the calcareous matter in a loose state of crystallization, and mixed with fine mud; the next higher division more regularly stratified, contains a large proportion of silica, containing quantities of waterworn. In the lowest division are portions of Stigmaria, Lepidodendron, Calamites, and Equisetaceæ. From the general character of this limestone, it must have been a littoral deposit from a quiet sea, subject, however, to various changes in tidal currents. The next in ascending order is a thick sandstone, the most important in quality, well adapted for architectural purposes. Above the sandstone is a limestone, of blue colour and fine texture, containing large numbers of flint nodules; the flint in some cases predominating so much as to form beds, interstratified with the limestone. These beds are prolific in Goniatites. Associated with these are innumerable Producti, on the upper surface of each stratum, lying in beds like the modern cockle or mussel. During the gradual deposit of stratum after stratum, corals of several beautiful varieties have fixed themselves to the hardened mud, or some dead shell at the bottom of the sea, and diligently erected their little temples; but they have never attained a size of more than five or six inches in height.

A slight change has now taken place in the diversity of other lands, or the sea-bottom, affecting the currents; the land has gradually risen, and we next find a deposit of a sandy composition, only a very few feet in thickness, upon which follow the innumerable beds of limestone, forming the Great Orton Scar series, of immense thickness. Its lower series partake of the character of a deep-sea deposit; but what power, and how directed, has raised them to their present high elevation, without considerably disturbing the underlying strata, is difficult to define. It forms the whole of Asby and Orton Scars, Hardendale Nab, and Knipe Scar, the highest peaks in the surrounding country, vying in height and precipitous escarpments with the old slate mountains. It may truly be termed the backbone of the area. There are many thousands of acres, known as Orton Scars, of this rock, perfectly bare, a wild barren stony wilderness, seldom relieved of its monotonous grey tone, save here and thereby the fronds of the bracken, or more delicately-shaped fern, in the crevices. It is not a plain of smooth stone, but broken up, and traversed in all directions by chasms ten or twenty feet deep, and from six to ten feet across. These are largest parallel to the strike, and are crossed at right angles by others, cutting it up into immense square blocks, in their turn broken by smaller fissures into smaller blocks; the surface stone is called the "clint" or "clint cap," which affords a good study of the way molecular attraction, or adhesion, has acted when the material forming the stone was in a viscid state. There is another set of fissures on Asby Scar, containing copper ore. In other formations of the same rock, small cracks have, by the procolation of water, often become soldered up by the crystallization of carbonate of lime. On forcing these open again, large specks of lead ore are sometimes found, a fact which, in part, may support the theory of lead being a deposit of crystallization of water. The characteristic fossils are Producti, which are very numerous, but ill preserved, and often distorted Euomphalus, Goniatites, and the black palatal bones of ganoid fishes.

Some of the limestones, and all the sandstones, in this series of rocks appear as though the material of which they are formed had settled one stratum above another, without any upheaval of the bottom of the sea, and are of one continued thickness throughout, to the outcrop; while others suggest the idea that the bottom has been gradually pushed up by some upheaving power, or that the current bringing the sedimentary matter failed to reach the outcrop, the stratum breaking off considerably further back, and the next stratum further still.

The next sandstone is very thin; above it is a thin limestone of a hard texture, in which Crinoids first became numerous; its last surface afforded a floor, on which have grown immense forests of Encrinites. Clay shale of a dark colour is next superimposed by a grey purplish sandstone, containing Stigmaria. In its uppermost beds on Harbyrn Rigg, immediately below the limestone, are beds of Pectens, and other shells. The succeeding limestone is very thin, and almost exclusively made up of broken coral; on two or three points, where it shows itself on high land, there is a stratum of coral,—clear evidence of an ancient coral reef. Next in order is a thin sandstone, generally overlaid by the next limestone: upon it rests another stratum of sandstone, associated with which are definite traces of another of the old coast-lines, exhibiting the variety of material forming a beach. The sandstone contains immense quantities of Stigmaria; at one place where a large area is laid bare, these root-like plants run in all directions, interlacing and overlapping each other in all directions, but in no case affording proof of rising into stems of Sigillaria. The calcareous and clayey deposits contain fragments of light shells and spines, of a pearly lustre, with an occasional small Trilobite; these have evidently been drifted, and quietly arranged in layers. Next is a limestone of deep-sea origin, the bluest in the series, and highly crystallized. It rises in thick large blocks, with scarcely any cleavage or natural cracks: its fossils are not numerous, but well preserved. Producti have attained their largest size; Crinoids are numerous. Upon this limestone rests a yellow sandstone, twelve feet thick,—the base of a series of shales, sandstones, and thin limestones, interstratified with which are the Reagill coal-seams. The most important of these is immediately above the sandstone, with a clay shale floor of two or three feet thick. The upper beds of the sandstone and this shale are full of Stigmaria, then follows the coal-seam, from six to twelve inches thick. We may consequently infer, that after this sandstone, with its clayey surface, became partially dry land, a rank vegetation of Sigillaria flourished, running their stigmarian roots deep into the clay and sand, till a sinking of the land brought the sea once more over it, and another deposit of clay shale six feet thick covered up the vegetable matter, gradually to be compressed and mineralized. Next above the clay shale is a hard limestone, called the ironstone; then follows another shale, with various shells, and some small Trilobites. Shales and sandstones then alternate two or three times, with sometimes a thin seam of coal, one of which is the "Crow Coal," two or three inches thick; upon these is another thin limestone of an irregular ferruginous character, affording beautiful variegated corals, Astræa and Cyathophyllum; upon it follows another sandstone, with clay shale, having a seam of coal about eleven inches thick. The coals, with their associated deposits, are of very small extent; the widest area they afford does not exceed half a mile, and, in the line of the strata, not more than four or five miles, beyond which they either have never been formed, or are overlaid. With respect to the coal formation in these rocks, as a general rule, wherever a clay shale is found lying on a sandstone, it is possible to find in the shale a trace of coal varying from a mere mark to twelve or thirteen inches. It is worthy of notice that the shales resting upon limestone are invariably full of animal- and destitute of vegetable-remains, while those upon sandstones are destitute of animal-remains.

We now cross a series of red-coloured limestones, formed in a great measure of Encrinitic fragments. Upon the first of these rests a grey sandstone, followed by limestone; a sandstone follows, the thickest in the series, and, from its general character, of deep-sea origin. The limestone overlying it, one of the thickest and most important, is the last of its race, for upon it rests the New Red Sandstone. These two may be traced all through this and the sister-county; in many places they are almost the only representatives of the Lower Carboniferous era, having either totally overlaid the others, or they have never been deposited. The Morland limestone, does not, however, immediately follow the thick sandstone, for between them, in the neighbourhood of Morland and King's Meaburn Scar, there may be found a thin limestone and sandstone. The limestone is of a deep red colour, and with the red clay shale above it, is perhaps the richest and most prolific in fossil remains of any. It is certainly a shallow-water deposit. Its upper beds are the site of a very luxuriant forest of crinoids; these are very numerous in the shales, and some may be found with the root attached in their original positions. Associated with them are quantities of the Fenestella, beautifully preserved, shells innumerable on every layer, and very frequently remains of small Trilobites. Thus, these animals range through the whole of this series, but are only found in deposits of a coast or shallow-water origin. The sandstone above is decidedly an ancient shore, or sandy beach. What the inhabitants of the land were, these rocks have afforded no record; but of the sea, the most gigantic form of animal life was the Orthoceras. These are numerous in the upper red limestones, varying in size from two to four and a half feet in length, perhaps the most gigantic size they have ever attained, and doubtless at that era they were lords of the sea.

The lower beds of the New Red Sandstone are the next rocks upon the Morland limestone. These, in the southern extremity of the basin, are breccias, of great thickness, followed by true sandstone. These, according to Professor Harkness, belong to the Permian; they encroach or recede from the outcrop of the Morland limestone, as the level of the country has permitted, but in no case are they overlaying it.

Having given the characteristic features of each rock, in the order of its deposit, the author gave an outline of the position they occupy, and of the forces he conceived to have been at work. It has been said the Old Red Sandstone lies unconformably upon the metamorphic slate rock: what its angle of dip might be the author could not say, but it is probably the same as that of the carboniferous rocks, which, as a general rule, is one in ten, or an angle of 5° rising S.W. and dipping N.E. In some places the angle is greater, as on Hardendale Fell and Nab, while in others they are almost horizontal, showing that agencies have been at work, irregularly heaving and lowering, throughout the long period of their formation. As a general rule, deposits made by water are laid horizontally; whence then the inclined angle at which these rocks now lie? There is no certain evidence of any upheaving power having caused it on the west side, but the disturbance is to be found on the east. Crossing over the basin in which is the New Red Sandstone, we come to another series of carboniferous rocks, similar to those enumerated, in being made up of limestones, sandstones, with coal seams, and clay shales, but with this difference, that they form a high mountain-range, known as the Crossfell Range. If we examine these in the lower series, we find first the Silurian as the lowest or Skiddaw slates traceable, with few exceptions, for many miles. Above it is a conglomerate of quartz, pebbles, and coarse grit, near Knock Pike, which on Roman Fell is the true Old Red Sandstone; next in ascending order are the carboniferous rocks, the lowest a limestone of a reddish colour, then a thick shale, followed by a sandstone, to be seen near Howgill Castle; this is again superimposed by a limestone, measuring 120 feet in thickness, and in many respects similar to the before-mentioned Morland limestone. This is traceable up to the middle of Crossfell, and immediately upon it rest the varied strata of millstone grit. To the south, however, along the same range, it is followed by a series of limestones, sandstones, coal, etc., and in one case a layer of basalt twenty-four yards thick, which has been overlaid. These are in the Dufton mining-district, where the Morland limestone is the chief lead-bearing stratum. From the top of this range, in the direction of Alston, may be crossed the strike of many different rocks, up to the last of the true coal-measures in Durham. After the formation of the last limestone in the valley, we see that the laws of nature have still gone on, raising and lowering the land, while the sea has continued to deposit other series of rocks, one upon another, each in its turn becoming dry land, and so on till the last of the coal-formations. Then comes a great convulsion, when a mighty crack has rent the hard surface of the earth from north to south, many miles in length, and now known to geologists as the Crossfell Fault; the effect of which has been to raise the east side into the high mountain-range of Crossfell; and to lower the west side, and form the rich basin of the Vale of Eden. So much has been done, between raising one side and lowering the other, that the Silurian and Old Red, which are found at Shap Wells and on Kaftland, have been brought to light, the distance between these, from the formations *in situ* at Shap, to the fault at Crossfell, being about ten miles direct; and the dip being about one in ten, these strata at present would be about a mile deep; so the upheaval on the one hand, and depression on the other, may be probable causes of the dip we now find.

"The volcanic rocks causing this disturbance, may be found, at the bottom of Knock Pike, as a granite, pushing up a cone of greenstone; also Dufton Pike as a micaceous porphyry; and Murton Pike similarly. At the time of this great disturbance, as the level of the one side was lowered, the New Red Sandstone sea rushed over the sunken country, from the north, tearing and rushing with a mighty force; breaking up into fragments the old-deposited limestone, and mingling with the heterogeneous mass a matrix of red sand, etc., in which way we may, in all probability, account for the immense masses of breccias resting upon the older strata, in the southern extremity of the New Red basin. The red sand brought by this flow, has overlaid the intervening valley so much, that, on the Crossfell side you may almost step from the New Red to the section of the Old. The sea, from which were deposited these rocks, eventually withdrew, and our county was then added to that dignified portion of the earth's surface, 'The Dry Land;' which it maintained throughout the long ages of the Oolitic, Cretaceous, and Tertiary periods, subject to the wear and tear of storms, and the convulsive throes of earthquakes, till Divine Providence directed the icy sea of the Drift era, to cover its naked surface with a coat of gravel, sand, and clay." It may be here remarked, that the shocks of earthquakes are not unknown even at the present day. So lately as the morning of the 6th of last December, this district was visited by a very sensible convulsive quiver.

SOCIETY OF ARTS.—*17th December.*—" On Mines, Minerals, and Miners of the United Kingdom." By Robert Hunt, Esq., F.R.S., of the Government School of Mines. A valuable paper full of important details. It has been reprinted by Professor Tennant from the 'Society of Arts Journal,' for gratuitous distribution.

ANTHROPOLOGICAL SOCIETY.—This society, founded on the 6th of January last, already numbers 120 members, and has commenced its meetings. It has been formed with the object of promoting the study of Anthropology in a strictly scientific manner; to study man in all his leading aspects, physical, mental, and historical; to investigate the laws of his origin and progress; to ascertain his place in nature and his relations to the inferior forms of life; and to attain these objects by patient investigation, careful induction, and the encouragement of all researches tending to establish a *de facto* science of man. Many of the researches undertaken by this society will fall legitimately within the provinces of Geology and Archæology. The following Council has been appointed:—*President*—Dr. James Hunt, F.S.A., F.R.S.L., For. Associate Anthropological Society of Paris, etc. *Vice-Presidents*—Captain Richard F. Burton, H.M. Consul at Fernando Po, etc.; Sir Charles Nicholson, Bart. *Honorary Secretary*—C. Carter Blake, Esq. *Honorary Foreign Secretary*—Edward B. Tylor, Esq. *Honorary Assistant Secretary*—Alfred Higgins, Esq. *Treasurer*—R. S. Charnock, Esq., F.S.A., F.R.G.S. *Council*—Rudolph Arundell, Esq.; Alan C. Blackstone, Esq., M.A., F.R.G.S.; W. Bollaert, Esq., F.R.G.S. Corr. Mem. Univ. Chile and Ethno. Socs., London and New York; Luke Burke, Esq., F.E.S.; J. F. Collingwood, Esq., F.G.S.; G. D. Gibb, Esq., M.D., F.G.S.; J. Hughlings Jackson, Esq., M.D., M.R.C.P.; S. J. Mackie, F.G.S., F.S.A., F.E.S.; Edward Pick, Esq., F.E.S.; T. S. Prideaux, Esq.; William Travers, Esq., M.R.C.S.; W. S. W. Vaux, Esq., M.A., F.S.A., F.R.S.L.

NOTES AND QUERIES.

ARTIFICIAL CAVERN.—A cave has been lately discovered in New Hampshire (America), whence the Indians of New England are supposed to have obtained their arrow-heads and flint-instruments. The cave is an artificial excavation, twenty-eight feet long, twelve wide, and eight or ten high, with a narrow mouth, in a jasper vein enclosed in "granite," of a steep mountain-spur on the banks of the Androscoggin, one and a half miles from Berlin Falls.

A CLASSIFIED AND STRATIGRAPHICAL LIST OF FOSSIL BIRDS. By S. J. Mackie, F.G.S.

× European area. † N. American. o S. American. * African. ‡ Asiatic. § Australasian.

Species.	Alluvial.	Diluvial.	Caverns.	Pleistocene.	Pliocene.	Miocene.	Eocene.	Maestricht.	Chalk.	Localities, Authorities, and References.
I. RAPTORES.										
1. *Diurni.*										
Cathartes							?			*Terrain d'eau douce*, Dép. du Cantal, Jourdan, Institut, 1837, p. 343.
——			o							*Caverns* (with *Megatherium*), Brazil, Lund, München Gelehrte Anzeigen ?; Gervais, Thèse, p. 31.
Lithornis vulturinus							×			*London Clay*, I. of Sheppey, Owen, Trans. Geol. Soc., 2 ser. t. vi. p. 206, and Brit. Foss. Mammalia and Birds, p. 549.
Vultur cinereus		×								*Diluvium*, Magdeburg, Wagner, Abh. Bay. Ac. p. 773; *V. fossilis* = Germar in Lethæa, t. ii. p. 824; Giebel, Fauna der Vorwelt, t. i. 2e part, p. 9; *Breccia*, Sardinia, Della Marmora, Journ. de Géol. t. iii. p. 313.
Nisus			×							*Caverns*, S. of France, *Caverns* of Sallèle and Bize, M. de Serres, Journ. de Géol. t. iii. p. 262.
Falco					×					*Pliocene*, Montpellier, Gervais, Zool. et Pal. Franç., p. 220.
——										*Cavern* (Berry Head), Torbay, Owen, Brit. Foss. Mamm. and Birds, p. 558.
Buteo			×							*Caverns*, Dép. de l'Aude, M. de Serres, Institut, 1842, p. 388.
——		×								*Breccia*, Sardinia, Wagner, Neues Jahrbuch, 1833, p. 334; Giebel, F. der Vorwelt, t. i. 2, p. 9.
Aquila		×								*Breccia*, Sardinia, Nitzsch, Neues Jahrb. 1833, p. 324; Giebel, F. der Vorwelt, t. i. 2, p. 9.
Pandion							×			*Gypsum*, Paris (*Parisien supérieure*), Cuvier, Ossemens Fossiles, t. v. p. 577.
2. *Nocturni.*										
Strix (s.-gen. *Ulula*)							×			*Gypsum*, Montmartre, Cuvier, Ossem. Foss.; Giebel, Fauna der Vorwelt, t. i. 2, p. 11.
——		×	×							*Cavern*, Nabrigas; *Diluvium*, Kostritz; Bibliothèque Universelle, 1835; Archives, t. xviii. p. 349; Isis, 1829, p. 739.
——			o							*Caverns*, Brazil, Lund, Institut, 1844, p. 291.
—— nyctea ?		?								*Breccia*, Sardinia, Nitzsch, Neues Jahrb. 1833, p. 324.
Bubo			×							*Caverns*, Dép. de l'Aude, M. de Serres, Institut, 1842, p. 388.
II. INSESSORES.										
Protornis Glarniensis							×			*Glaris slate*, Plattenburg, H. v. Meyer, Neues Jahrb. 1839, p. 682: 1840, p. 211; 1841, p. 187; 1844, p. 388.
1. *Dentirostratæ.*										
Motacilla		?								*Breccia*, Cette, Wagner, Abh. Bayer. Acad. 1832, p. 751.
Turdus Bresciensis		?								*Breccia*, Cette, Wagner, op. cit.
——		×								*Breccia*, Sardinia, Wagner, Neues Jahrb. 1833, p. 772; *Breccia*, Nice, Wagner, Abh. Bay. Ac. 1832; Philosophical Transactions, 1794, t. i. p. 412; *Diluvium*, Valley of the Lahn, H. v. Meyer, Neues Jahrb. 1846, p. 515.
——						×				*Miocene*, Weisenau, H. v. Meyer, Neues Jahrb. 1843, p. 399.
Anabates *vel* Opetiorhynchus			o							*Caverns*, Brazil, Lund, Bulletin Acad. Copenhägen, 1841; Giebel, Palæozool., p. 313; F. der Vorwelt, i. 2, p. 13.
2. *Fissirostratæ.*										*Diluvium*, Quedlimbourg, Giebel, Fauna der Vorwelt, i. 2, p. 18.

3. *Conirostratæ.*										
Fringilla trochanteria		×								*Diluvium*, Quedlimbourg, GIEBEL, Fauna der Vorwelt, i. 2, p. 15.
———		×								*Breccia*, Sardinia, WAGNER, Abh. Bayer. Acad. 1832, p. 751.
———						×				*Miocene*, Weisenau, Neues Jahrb. 1839, p. 399; Sansan, LARTET, Institut, 1839, p. 263.
Alauda		×	×							*Breccia*, Sardinia, WAGNER, op. cit.; *Cavern*, Kirkdale, BUCKLAND, Reliq. Diluv.; Liége, SCHMERLING.
Corvus fossilis		×								*Diluvium*, Quedlimbourg, GIEBEL, Fauna der Vorwelt, i. 2, p. 16.
——— crassipennis		×								*Diluvium*, Quedlimbourg, GIEBEL, Fauna der Vorwelt, i. 2, p. 16.
——— corone? vel corax?		×	×							*Diluvium*, Valley of the Lahn; H. v. MEYER; *Breccia*, Sardinia, WAGNER, Abh. Bayer. Acad. 1832, p. 751; *Cavern*, Kirkdale, BUCKLAND, Reliq. Diluv.
——— pica?			×							*Cavern*, Brengues, PUEL, Bull. Soc. Géol. de Fr. 1837, p. 43; Kirkdale, BUCKLAND, Reliq. Diluv.
4. *Tenuirostratæ.*										
Dendrocolaptes			o							*Caverns*, Brazil, LUND, Münch. Gel. Anzeig. 1842, p. 886.
III. SCANSORES.										
Picus martius		?								*Breccia*, Sardinia, WAGNER, Abh. Acad. Bayer. 1832, p. 751.
Coccyzus		o								*Caverns*, Brazil, LUND, Münch. Gel. Anzeig. 1841.
Capito		o								*Caverns*, Brazil, LUND, Münch. Gel. Anzeig. 1842.
Psittacus		o								
IV. VOLITORES.										
Cypselus collaris			o							*Caverns*, Brazil, LUND } Münch. Gel. Anzeig. 1842, p. 886; GERVAIS, Thèse, p. 34.
Caprimulgus			o							*Caverns*, Brazil, CLAUSSEN }
Halcyornis toliapicus							×			*London Clay*, Isle of Sheppey, OWEN, Brit. Foss. Mammalia, p. 554.
V. RASORES.										
1. *Gemitores.*										
Columba			×							*Caverns*, Kirkdale, BUCKLAND, Reliq. Diluv.; MARCEL DE SERRES, Journ. Géol. t. iii. p. 362.
Didus ineptus	*	?								*Alluvium* (et *Diluvium*?), Bourbon and Mauritius, STRICKLAND and MELVILLE on the Dodo.
Pezophaps solitaria	*	?								
2. *Clamatores.*										
Tetrao		×	×							*Diluvium* and *Caverns* of Brengues, PUEL, Bull. Soc. Géol., vol. ix. p. 45.
Coturnix?								×		*Gypsum*, Paris, CUVIER, Ossem. Foss., 4ᵉ édit. t. v.
Perdrix							×			*Miocene*, Weisenau, GIEBEL, Fauna der Vorwelt, i. 2. p. 22; *Miocene*, Auvergne, GERVAIS, Thèse, p. 22.
———		×	×							*Caverns*, Liége, SCHMERLING; Bize, MARCEL DE SERRES, Journ. Géol. t. iii.; Kirkdale, BUCKLAND, Reliq. Diluv.; *Diluvium*, Valley of the Lahn, H. v. MEYER.
———			o							*Caverns*, Brazil, LUND, Münch. Gel. Anzeig. 1842.
Phasianus		×	×							*Cavern*, Bize, MARCEL DE SERRES; *Diluvium*, Paris, GERVAIS, Journ. Géol. t. iii. p. 263; Institut, 1844, t. xii. p. 293.
Gallus							?			*Molasse* du Mont de la Molière, GERVAIS, Thèse, p. 27; *Sable Tertiaire*, Auvergne.
——— Bravardi							?			*Miocene?* Ardé, GERVAIS.
——— domesticus?		×	×							*Caverns*, Lunel-Viel, MARCEL DE SERRES, op. Lunel-Viel; Liége, SCHMERLING; *Diluvium*, Kostritz; Valley of the Lahn, H. v. MEYER.
Numida		?								*Loess*, Sasbach, H. v. MEYER.
Tinamus			o							*Caverns*, Brazil, LUND, Münch. Gel. Anzeig. 1842.

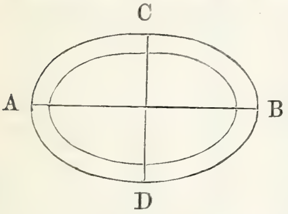
FOSSIL BIRDS—*continued*.

× European area. † N. American. o S. American. * African. ‡ Asiatic. § Australasian.

SPECIES.	Alluvial.	Diluvial.	Caverns.	Pleistocene.	Pliocene.	Miocene.	Eocene.	Maestricht.	Chalk.	LOCALITIES, AUTHORITIES, AND REFERENCES.
VI. CURSORES.										
1. *Apteryx*, 2 sp. (? the same as the recent *A. Mantelli*, *Oweni*, or *australis*)	?									
Rhea			o							*Caverns*, Brazil, LUND, Münch. Gel. Anzeig. 1842
——			o							
Dinornis giganteus	§	?								*Alluvium* and *Diluvium* ?, New Zealand, Trans. Zool. Soc. vol. iii. and vol. iv. etc.; Mag. Nat. Hist. vol. xii. p. 444, etc.
—— struthioides	§	?								
—— didiformis	§	?								
—— curtus	§	?								
—— crassus	§	?								
—— rheides	§	?								
—— casuarius	§	?								
—— otidiformis	§	?								
—— elephantopus	§	?								
—— robustus	§	?								
Palapteryx ingens	§	?								
—— dromioides	§	?								
—— geranoides	§	?								
Aptornis	§	?								
Æpyornis, Eggs from Madagascar and bones	?	?								*Alluvial*, Isidore Geoffroy, Compt. Rend. Ac. des Sc. 27 Janvier, 1851.
Moa	§									*Alluvial* and *Recent*, N. Zealand. Eggs, W. MANTELL, Athenæum, 25 Sept. 1847; Bibliothèque de Genève, Archives, t. vi. p. 266.
Lithornis ? emuinus								×		*London Clay*, Isle of Sheppey, BOWERBANK, Annals Nat. Hist. (1851) and Rep. Brit. Assoc. 1851, Sect. p. 55.
Gastornis Parisiensis										*Lower Eocene*, Meudon, near Paris. OWEN, Geol. Soc. Journ. vol. xii. p. 204, pl. 3. f. 1.
VII. GRALLATORES.										
1. *Pressirostratæ.*										
Otis breviceps		×								*Diluvium*, Quedlinbourg, GIEBEL, Fauna der Vorwelt, i. 2. p. 26.
Microdactylus			o							*Caverns*, Brazil, LUND, Münch. Gel. Anzeig. 1842, p. 886.
2. *Cultirostratæ.*										
Phœnicopterus Croizeti						×				*Miocene*, Auvergne, GERVAIS, Thèse, p. 39.
Ciconia ?										

2. *Cultirostratæ.*										
Phœnicopterus Croizeti						×				*Miocene*, Auvergne, Gervais, Thèse, p. 39. *Miocene*, Wiesbaden, Meyer, Neues Jahrb. 1839, p. 77.
Tantalus Bresciensis		×								*Breccia*, Sardinia, Della Marmora, Journ. Géol. t. iii. p. 310.
3. *Longirostratæ.*										
Numenius gypsorum							×			*Gypsum*, Montmartre, Gervais, Thèse, p. 18: Cuvier, Ossem. Foss., 4ᵉ édit. t. v. p. 597, pl. 154, fig. 14 = *Tantalus fossilis* auctorum.
Scolopax ?							×			*Gypsum*, Montmartre, Gervais, Thèse, p. 18.
——— —						×				*Miocene*, Weisenau, H. v. Meyer, Neues Jahrb. 1843, p. 398.
——— ——?					×					*Pliocene*, Oeningen, Blumenbach, Spec.; Karg, Denks.; Giebel, F. der Vorwelt, i. 2, p. 28.
———			×							*Cavern*, Kirkdale, Buckland, Reliq. Diluv.; *Tuf diluvien*, Meissen, Giebel, Fauna der Vorwelt, i. 2, p. 28.
——— ?								×		*Greensand (Senonian)*, New Jersey, Harlan, Phys. et Med. Res., p. 280.
Pelidna ?							×			*Gypsum*, Montmartre, Cuvier, Ossem. Foss., 4ᵉ édit. t. v.; Gervais, Thèse, p. 18.
Tringa ?							×			*Gypsum*, Montmartre, Gervais, Thèse, pp. 16 and 18.
4. *Macrodactyli.*										
Fulica ?						?				*Lignites*, Kaltennordheim, Schlotheim, Petrefacten, p. 26; Giebel, Fauna der Vorwelt, p. 29.
Rallus		?								*Breccia*, Montmorency, C. Prevost et Dunoyer, Institut, 1844, t. xii. p. 293.
———			o							*Caverns*, Brazil, Lund, Münch. Gel. Anzeig. 1842.
Notornis Mantelli	×									*Alluvium*, New Zealand, Owen, Trans. Zool. Soc.; Mantell, Ann. Nat. Hist. 1850; Bibl. Univ. 1851; Archives, t. xvi. p. 73.
VIII. NATATORES.										
1. *Longipennatæ.*										
Larus priscus		×								*Diluvium*, Quedlimbourg, Giebel, Fauna der Vorwelt, i. 2, p. 31.
——— sterna ?		?								*Breccia*, Nice, Wagner, Abh. Bay. Acad. 1832, p. 772.
2. *Totipalmatæ.*										
Pelicanus							×			*Gypsum*, Montmartre, Cuvier, Ossem. Foss., 4ᵉ édit. t. v. p. 596.
Phalacrocorax						?				*Tertiary (Palustral Limestone)*, Monbach, Giebel, Neues Jahrb. 1839, p. 70, and Fauna der Vorwelt, p. 33.
3. *Lamellirostratæ.*										
Cygnus olor ?			×							*Caverns*, Lunel-Viel, Marcel de Serres, Dubreuil, et Jean-Jean, op. Lunel-Viel.
——— ferus										*Pliocene*, Grays, Essex, Owen, Geol. Soc. Journal, vol. xii. p. 211, pl. 3, fig. 13.
Anser		×								*Diluvium*, Lawford and France, Buckland, Rel. Dil.; Gervais, Thèse; Giebel, F. der Vorwelt.
Anas						×				*Tertiary*, Auvergne, Gervais, Thèse, p. 24.
———		?								*Breccia*, Sardinia, Wagner, Abh. Bayer. Acad. 1832, p. 751.
———		×	×							*Diluvium*, Valley of the Lahn, H. v. Meyer; *Cavern*, Kirkdale, Buckland, Reliq. Diluv.
Colymbus			×							*Cavern*, Kirkdale, Buckland, Reliq. Diluv.
Mergus Ronzoni						×				*Lower Miocene*, Ronzon, near Le Puy, Gervais, Thèse, p. 22 (=*M. serrata*).
BIRD-BONES *incerti sedis.*										
Palæornis Cliftii										*Wealden*, Cuckfield, Mantell, Geol. Trans., series ii. vol. v. pl. 13, fig. 6; Wonders of Geology, 6th ed. p. 442, and 7th ed. p. 453.
?										*Greensand*, Cambridge, discovered by Lucas Barrett.
?										*Lower Eocene*, Woolwich beds, Counter Hill, Prestwich, Q.J.G.S., vol. x. p. 157; also in Woolwich beds, near Sydenham (Mr. Wakes' collection).
?										*Stonesfield slate*, *fide* the Rev. J. Dennis.
?										*Triassic*, Chatham coal-field, North Carolina, Dr. Emmons, American Geology, part 6.

Note on a Progressive Change in the Form of the Earth.—If it be assumed that the earth has cooled to its present temperature from a state of incandescence, it will follow that its form is subject to a slow progressive change. Let A C B D be the spheroid of equilibrium at any epoch, the form of this spheroid depends on its magnitude and the velocity of rotation. If either of these changes, the form will change. Now let the spheroid A C B D contract, by cooling, to the spheroid $a\ c\ b\ d$, whose surface may be considered as parallel to A C B D; when the amount of contraction is small, therefore B b is equal to C c. If these equals be taken from both terms of the ratio O B : O C that ratio will be increased; therefore O b : O c is greater than O B : O C; that is, the equatorial diameter has a greater ratio to the polar diameter than it had before the contraction took place. The effect of this is equivalent to a constant accumulation of matter at the equator in *excess* of what is due to the velocity of rotation. This excess could never attain to any considerable magnitude so long as the earth was in a fluid state, as the change would take place *per gradum* from the old to the new spheroidal form of equilibrium; but when the external crust became sufficiently rigid to oppose resistance to the change of form, the alteration would take place *per saltum* at the weakest points. This is probably worthy of the attention of those who have the necessary qualifications for discussing mathematically the difficult but intensely interesting subject—the physical causes of geological phenomena. To those who feel a difficulty in understanding how contraction *towards* the centre can produce upheavals *from* the centre, I recommend the following experiment. Fuse a bead of carbonate of soda in the blowpipe flame. Dip the bead into a little powder of silex and fuse again. Watch the cooling through a magnifier. Conical hills start up and mountain-chains are formed as if by magic. The experiment may be repeated any number of times with the same bead, which proves that the elevations are not caused by escaping carbonic acid gas, but by the contraction of the external cooling surface on the internal fluid mass.—G. H.



Mammalian Remains in the Hampshire Gravel.—Sir,—In the number of your periodical for November last, p. 427, you were good enough to publish a communication from me, from which it might be inferred that my inquiries for animal remains, in the gravel deposits of this neighbourhood, had been fruitless.

I have since, however, by inquiring of gravel-diggers, been made acquainted with, and have to-day seen, a molar tooth of an elephant from the gravel at Swathling, which is a village about three miles east of this town. This is the only instance of the kind in this neighbourhood with which I am acquainted; but I remember meeting somewhere with the mention of the existence of mammalian remains in the gravel at a locality at the back of the Isle of Wight: perhaps you might be able to tell me if there are any other such fossil-bearing spots, in the gravel, recorded as existing in the county of Hampshire?

I was likewise shown to-day a bunch of sea (?) shells from the gravel, also from the neighbourhood of Swathling, but from a different locality to where the first-mentioned fossil was found. W. T. Nicolls.

Southampton, February 9, 1863.

New Species of Fish from the Crag.—Dear Sir,—I believe that up to the present time the remains of Placoid fish only have been found in the Red Crag of England. It is, therefore, a matter of importance to add fish of any other groups to its fauna. A friend of mine received last year, from Aldborough, in Suffolk, a hardened slab of crag, containing a portion of the vertebral column and fins of a fish, which certainly did not appear to belong to any of the forms before known. It was shown to Professor Huxley, who affirmed that it was in too imperfect a state of preservation to warrant any decision as to its genus or species. Sir Philip Egerton likewise saw the specimen, but would not venture to say more than Professor Huxley. My friend then took his specimen to Dr. Günter, of the British Museum, who is intimately acquainted with recent species of fish; after a close examination of the specimen, he came to the conclusion that, judging from the position and form of the fins, the fish to which they belonged was probably closely allied to the common cod (Gadus); but from the absence of any skull-bones, and its generally imperfect state of preservation, it was impossible to speak with more certainty. I enclose you a sketch of the specimen, which measures nearly a foot in length. It is to be hoped that geologists visiting the neighbourhood of Aldborough will take the opportunity to make a close examination of the hardened slabs of crag, which are, I believe, abundantly scattered on some parts of the shore; and I trust that it will not be long before further specimens are obtained, which will throw more light upon the nature and affinities of the fish-remains in question.

I should observe that there is no doubt as to the specimen being derived from Crag strata, as the block contains impressions of various well-known crag fossils; among others, I may mention *Emarginula fissura*, which, I believe, does not range lower than the Crag. Truly yours, E. R. LANKESTER.

8, *Savile Row*, *February* 6, 1863.

FLINT IMPLEMENT NEAR NORWICH.—Sir,—Though recent discoveries have made it difficult to say where geology ends and archæology begins, I cannot but feel that my present communication belongs rather to the latter than the former branch of science; nevertheless, I shall be glad if you can find a place for it in an early number of the 'Geologist.'

I was walking, on Saturday, Jan. 18, 1862, from Norwich to Caistor, an extensive Roman encampment about four miles south of the city, and observed, at various places on the road, heaps of flints intended for road repairs. They appeared to be of three kinds, or, more correctly, derived from three sources, viz.:—

1st. Those recently extracted from the chalk of the district.

2nd. Those taken from the supracretaceous gravel-beds.

3rd. Those which had been picked off the neighbouring fields, where they had been turned up by the plough or harrow.

So far as I could judge, the three classes were kept separate, that is, each heap appeared to consist of one kind only.

At about two miles and a half from Norwich my eye casually rested on a flint, which I believed to be an "implement," lying on a small heap of the third kind; and, on stepping back, my first impression proved to be correct, as I took up the "implement" I now send you.

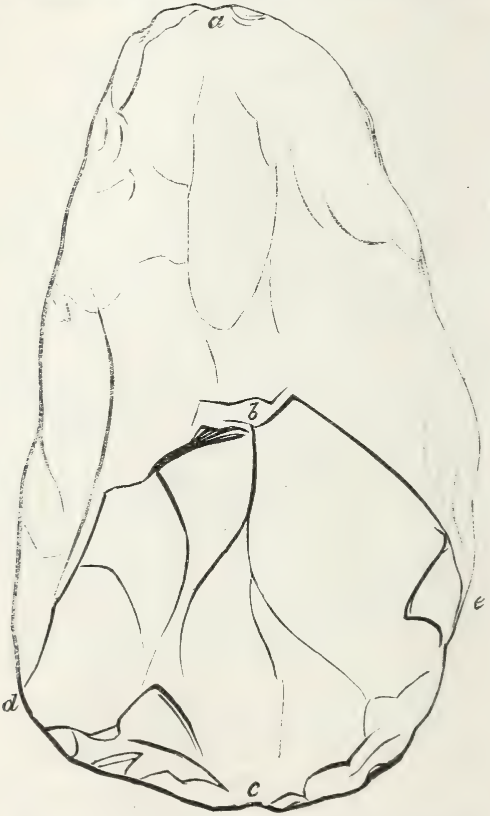
I endeavoured to discover its "trail," but without success. The workmen assured me they had never found anything of the kind in the gravel-beds, or indeed anywhere. The object was evidently new to them. They were of opinion that it had been "ploughed up," and picked off the ground with other stones for road repairs. The Rev. Mr. Gunn subsequently informed me that it is the only specimen of its type which has been found in Norfolk.

You will observe that it has several iron stains, especially at some of the edges and angles, and also that it has some slight traces of polish;

consequences and proofs, probably, of the treatment it has endured since its deposition.

Mr. Evans, of Hemel Hempstead, to whom I some time since submitted it, has been so kind as to send me the following opinion respecting it:—

"I have examined it carefully, and the conclusion to which I arrive is that it does not belong to the 'Drift period,' but that it must be classed among the implements of the so-called 'Stone period.' The general form is very much that of the ordinary stone 'celt,' adapted for cutting at the broad end; a portion, however, of the edge has been broken or worn away. I am not sure whether there are not some traces of its having been ground on some parts of its surface.



Flint Implement from between Norwich and Caistor.

"Judging from the appearance, I should say that the 'celt' had been lying upon or near the surface for a considerable time, in rather a sandy soil. It seems to be altered superficially to a considerable depth, and the numerous rusty marks upon it testify to its having frequently been brought into contact with the plough and harrow, whose rude assaults its tough constitution has enabled it to withstand."*

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* Extract of a letter from John Evans, Esq., F.S.A., F.G.S., June 18th, 1862.

It seems desirable to place on record the discovery of specimens like the above, even though they may add nothing to the evidence on the question of human antiquity.—I am, yours, etc., WM. PENGELLY.

Lamorna, Torquay.

[The implement which I have drawn above, from the specimen kindly forwarded to me by Mr. Pengelly, appears to me to present the singular appearance of having been manufactured out of one of the large pointed implements of the Drift of the Amiens and Hoxne pattern. All the portion from *a*, *d*, *b*, *e*, *a*, is smoothed by wear or friction, while the lines of fracture in the remaining portion, *d*, *b*, *e*, *c*, *d*, are sharp and fresh, of subsequent workmanship, but not of recent fabrication.—ED. GEOL.]

MAMMALIAN REMAINS AT DULWICH.—In the 5th volume of the 'Geologist,' page 302, Mr. A. Bott announced the discovery of the tooth of a mammalian animal from the Woolwich beds near Dulwich.

Since the publication of that notice, Mr. Bott has kindly placed at my disposal a most accurate and beautiful photograph of the tooth in question. I regret very much that a careful examination of it does not permit me to decide with any certainty on the generic position of the animal to which it belonged. I consider the tooth in question to be a canine; and after a comparison between it and the *Coryphodon* of the Lower Eocene of England and France, think it highly probable that it may have belonged to that genus. The identification, however, of any species of herbivorous mammal by means of one solitary canine tooth is exceedingly to be deprecated.—C. CARTER BLAKE.

EXTENT OF THE DRIFT.—The low country in the east of England, north of the Thames, and all Wales, is more or less covered with drift; but the south of England, the Wealden area especially, and the country south of the Bristol Channel, is in general destitute of it, except at very low levels on and near the shore at Brighton, Selsey Bill, etc. On both sides of the valley of the Firth, and inland over the whole of Scotland, there are numerous indications of glacial action, both in the older boulder-clay, gravel, and later boulder-clay and gravels that more or less cover the country, and in the frequent striation of the rocks visible where the drift has been freshly cleared. By the Firth Professor Ramsay has observed these striations to run roughly from east to west in the main line of the valley; and north of the Grampian mountains, Professor Jamieson states that they generally follow the great slopes of the country on the east and west sides of the chief watershed. These striations, Professor Ramsay thinks, were probably formed at a time when the whole country was cased in ice, like the north of Greenland at the present day, and during the period in which the older boulder-clay was formed. This was afterwards submerged, and the younger drift deposited; and on the re-emergence of the land, a second set of glaciers, of smaller size, filled many of the valleys.

From the great Laurentian chain to the banks of the Ohio, the central plains of North America are more or less covered with boulder-clay and drift, often several hundreds of feet in thickness. When removed, the rocks on which those deposits rest are found to be very generally grooved and striated; the striations running more or less from north to south. Examples are everywhere to be met with in that region; but these occurrences have been more especially described near the Falls of Niagara, on the shores of the Hudson, the eastern flanks of the Catskill Mountains, and along the side of the escarpment from north to south up to the high minor gorge that traverses the range from east to west; and by Mountain House, nearly 3000 feet above the sea, the striations bend round and cross the watershed, as if, according to Professor Ramsay, when the land was submerged to a certain level, the ice, previously grating along the side of the escarpment, had found a passage to the west, through what is now an upland valley.

Bone-Cave at Cefn, Flintshire.—Cefn Cave was first explored by the Rev. Edward Stanley, late Bishop of Norwich, in 1832. It lies in the carboniferous limestone of Denbighshire, near St. Asaph, in the Vale of Cyffredan, on the west side of the Vale of Ebwy. It is on the side and near the top of a steep escarpment overlooking the river. Most of the bones were probably dragged in by beasts of prey, of which it served as the den; others may have dropped in through cracks in the roof. The following species, named by Dr. Falconer, have been observed; many of these were in the possession of Lieut.-Colonel Watkins Wynne, on whose property the cave lies:—*Elephas antiquus, Rhinoceros hemitæchus, Rhinoceros tichorinus, Hippopotamus major, Bos, Cervus*, etc. No human remains have been found in it, but human bones have been found at a lower level in the base of the same escarpment. In the Vale of Clwyd there is much stratified drift, with ice-scratched boulders and sea-shells; and Professor Ramsay says the cave has clearly been submerged during the glacial or drift period, as he and Dr. Falconer have found fragments of cockles and other marine shells in the clay, and amongst the gravel and stones with which it is filled.

Peat Sandstone.—Dr. Mega states, in 'Hameberg's Journal,' that there occurs in the heaths of Hannover (America) a kind of moss-bed pan, which consists of sand cemented by peat; though, on account of its colour, it is generally thought to be either bog-iron or iron-sandstone. It is formed by the evaporation of bog-water from a nearly pure quartz sand. The grains of sand first acquire a yellow, then a brown, and finally a dark brown or black colour. When the peat solution evaporates, the peat is left in a form no longer soluble in water. It gradually fills up the interstices of the sand, and makes an impenetrable mass possessing a good degree of hardness and tenacity. When this peat sandstone is placed in ammonia a dark solution of humic acid is obtained, and nothing but white sand remains.

Copper Age of America.—M. Morlot has drawn attention to this topic. He says:—Some more light seems to be thrown on the date of the "Copper Age" by the fact recorded in Schoolcraft's 'Indian Tribes' (vol. i. p. 133). Twelve miles from Dundas, Canada West, there were discovered, about 1837, extensive ossuaries, and among the bones were found amulets of the red pipestone of Coteau des Prairies (Minnesota), copper bracelets like those of the old graves in the West, a *Pyrula spirata* and a *P. perversa*, both from the Gulf of Mexico, four antique pipes used without stems, and corresponding with an antique pipe from an ancient grave at Thunder Bay, Michigan, a worked gorget of sea-shell, with red nacre and shell-beads of the same kind as those said to have been found in the gigantic mound of Grave Creek, Virginia. All this goes to characterize the ossuaries of Beverley as belonging to the time of the mound-builders—that is, of the "Copper Age." But these ossuaries have also yielded some beads and baldries of glass and coloured enamel (figured by Schoolcraft, pl. xxiv. and xxv.). This find is not single in its kind, for according to Schoolcraft ('Lead Mines of Missouri,' 2nd part, 1819), beads agreeing completely with those of Beverley were found in 1817 in antique Indian graves, at Hamburg, Erie county, New York. Schoolcraft distinctly points out the beads as of European origin. This M. Morlot thinks unquestionable, as the native industry of America never produced glass or enamel; and he further states that similar beads have been obtained in Sweden, and Denmark, and Germany. These beads are not, according to Minutoli's paper

'On the Stained Glass of the Ancients' (Berlin, 1836), of Roman origin, and are found in old Etruscan graves; also in Egypt, where they may have been manufactured at Alexandria before the Christian era, perhaps as far back as the olden times of the Phœnicians, who were celebrated for their glass-ware as well as for their commerce and their extensive navigation. The discovery of America by the Phœnicians has been strongly suspected by many, and it would account, in M. Morlot's opinion, in a very natural manner for the tradition of the Atlantis. The fact is in itself, he thinks, far from improbable, when we reflect that long before the Christian era the Alexandrian astronomers knew the earth to be round, and that one of them, Eratosthenes (third century before Christ), calculated the circumference of the earth with a surprising degree of accuracy. The find at Beverley, then, goes to show, M. Morlot conceives, that a given moment of the American "Copper Age" coincided with a given moment of that European civilization to which the enamelled beads belonged and which could hardly reach lower down than the Christian era, while it appears to go as far back as five or even ten centuries earlier. Of course, it is not to be understood that the American "Copper Age" was wholly parallel with the Phœnician period. It may have begun sooner, and may have lasted later; but, if this view be correct, there is thus, by indirect means, a chronological determination for the North American "Copper Age," far from precise, but which further discoveries will correct.

Argyllite.—A new mineral under this name was described in a late number of Newton's 'London Journal of Arts,' by Mr. Lewis Thompson. For some years past, a nickel mine has been worked on the estate of the Duke of Argyle, at Inverary, and from time to time borings have been made to discover the extent of the vein, and, from amongst the different kinds of minerals thus obtained, one sample was found by the Duke to possess the power of reflecting light. The mineral was found in very small quantities, but curiosity being excited to know what it was, a portion was sent to Mr. Thompson for analysis. He asserts it to be a compound of lead, vanadium, and sulphur—a combination that he says has never before been noticed. The crystals are very small and by microscopic examination were found to be 12-sided, or dodecahedrons. This discovery recalled to Mr. Thompson's recollection a peculiar kind of copper-ore he had obtained many years ago from near Fowey, in Cornwall. This ore had always to be melted by itself in Swansea, and the copper obtained from it could not be rolled in sheets. The cause of this was not examined into at that time; but as the ore contained well-formed crystals, resembling galena mixed with copper, Mr. Thompson suspected it might be the same kind of ore as that obtained at Inverary. Specimens of this Fowey ore have now been subjected to careful analysis, and found to contain—lead, 60·8; vanadium, 20·5; sulphur, 18·7=100. The specific gravity is 6·04; the colour a dark lead-grey, with considerable lustre. The form of the crystal is a rhombic dodecahedron. Before the blowpipe it decrepitates slightly; with borax it yields a beautiful bluish-green bead in the reducing flame. It is acted upon by boiling nitric acid, and affords a bright blue solution. Very small quantities have as yet been obtained, but mineralogists may now be led to search for larger deposits, which, if obtained, will prove valuable to the owners of the mines. Vanadium forms a beautiful dark-blue colour on silk with tanno-gallic acid, which is stated to be very permanent; but no sufficient supply of this metal has yet been obtained for its commercial use.

REVIEWS.

The Land and Freshwater Mollusks indigenous to, or naturalized in, the British Isles. By Lovell Reeve, F.L.S. London: Reeve and Co. 1863.

One thing must be admitted of Mr. Reeve's books: they are always got out with great care and taste. The volume before us is another example, and is, typographically, and in size, paper, and illustrations, the *beau idéal* of what such a book should be. It is of most handy and convenient size, clearly printed, and illustrated with very characteristically and very nicely executed woodcuts. The matter is also good—we need scarcely say that of Mr. Reeve's conchological labours—and very conveniently arranged. First, is an Alphabetical List of Species, then a Systematic List, followed by an Analytical Key, displaying at a glance the natural groups into families and genera, and the characteristic features of each species. A map of both hemispheres shows the boundaries of the Caucasian province, over which the British species range, and the position of this area in respect to other areas, and the general terrestrial system. Of the broad, general divisions of molluscan distribution, Mr. Reeve recognizes in the eastern hemisphere the following provinces:—the Caucasian, the West African, South African, Malagan, Australian; in the western hemisphere—the North American, Columbian, Brazilian, Bolivian, and Chilian provinces. After a brief description of the appearance, condition, and extent of the British fauna, we pass on to some 240 pages of descriptive matter, giving the accepted names of each species, its synonyms, and its characters and habitats.

So important as fossil shells are in the palæontological history of the earth's past states, a good work like the present, on British shells, cannot fail to be of service to the geologist. Other books, such as Hanley and Forbes's 'British Mollusca,' exist, but such an elaborate and costly work is much beyond the attainments of ordinary students; while Mr. Reeve's less pretentious and inexpensive book contains all essential information. It is by the practical study of British shells that those British geologists who are not travellers must obtain their knowledge for the comparison of fossil mollusks, and the comprehension of the probable conditions of their ancient existence. The concluding chapter of Mr. Reeve's book, "On the Distribution and Origin of Species," will be read, however, by the practical geologist and naturalist with much interest. We all remember the late Edward Forbes's theories of Centres of Creation, and how fully the idea of species taking their origin each from a single pair, the progeny of which spread around and around the birthplace of its progenitors into wider and wider geographical areas, was accordant with popular notions. Mr. Reeve takes a very opposite view, and pleads for a plurality of originating individuals on the following important grounds:—Firstly, that land species, with greater facilities of migration than freshwater, are less widely and evenly diffused; secondly, that land and freshwater species of opposite hemispheres are not always representative, but sometimes identical; and, thirdly, that the range of land and freshwater species over areas or zoological provinces indicated by uniformity of type, is not arrested by the intervention of seas.

The following extract will suffice to show the important bearing of this chapter on geological science:—"The doctrine of the migration of all the individuals of a species from a single parent (or pair) involves the conclusion, that species permanent, as I think, in their character, and immutable, diminish in number in their march from the specific centre of a province towards its confines. Out of the many hundreds of land-mollusks inhabiting the Caucasian province at its specific centre, only ninety have reached the British Isles; of which thirty-five stop short of Scotland, and nineteen in Ireland. Their progress northwards, it may be argued, is arrested, to a great extent, by a change of climate, and in all directions by foes, by mountain-barriers, by rivers, and by other physical and unknown causes. It will readily be conceded that land-species have greater facilities of locomotion than freshwater species especially inhabiting stagnant ponds and ditches; and it should follow, according to the doctrine of migration, that the further off freshwater species are from the specific centre of a province, the more diminished in number than land-species they would be. The very contrary is the fact; out of five hundred and sixty species of Helix inhabiting the Caucasian province, a very large proportion of which are assembled at its specific centre, we have but twenty-four in Britain, of which only eleven range throughout. The disproportion in the number of Clausilia is larger still. This genus is especially populous at its specific centre. Between two and three hundred species inhabit Austria and Hungary, yet we have but four in Britain, of which only one ranges throughout. Let us now turn to the sluggish mud-dwelling Lymnæacea of the ponds and ditches of the province. There are not six species, it may be safely stated, in all Europe more than there are in Britain. They have no particular centre of creation. There is no evidence to show whether the alleged primogenitors of our British species were created in Siberia, Hungary, or Thibet. There is scarcely any variation, either in the form or number of the species in those remote localities."

The other topics are equally well discussed, and valuable facts brought to bear upon them; and altogether, although the arguments are very concisely stated, we have very valuable considerations very lucidly put. A complete bibliographical list and an excellent index complete this useful volume, which will doubtless, and deservedly, find a proper place in most naturalists' libraries.

Year Book of Facts, 1863. By John Timbs, F.S.A.
London: Lockwood and Co. 1863.

Every year Mr. Timbs issues, and we receive, a 'Book of Facts.' These are not, however, Mr. Timbs's facts, but the property of numerous people. The book is, as is well known, a series of cuttings from various publications, but not the less a useful book that it is composed of the "pickings" of wise men's brains. If we cannot always depend on the judgment and knowledge of the compiler, as displayed in his selections, or if we should think him a little too much attached to certain publications, and a little oblivious of or antagonistic towards others, he at least is not altogether unamicable, for he shows his partiality by naming and praising his favourites, and with respect to the rest, merely uses their matter, and consigns to oblivion their names and their fames. In the present volume the materials are beyond the average value of Mr. Timbs's former year-books; and besides the section devoted specially to Geology, there are scattered articles in various other portions interesting to geologists, such as the "origin of petroleum," "machine for cutting coal worked by compressed air," "Ransome's artificial stone," coal "and iron of South Yorkshire," "artesian wells," "secular cooling of the earth," and "the relations between earthquakes and magnetic disturbances."

Evidence as to Man's Place in Nature. By Prof. Huxley, F.R.S. 8vo. Williams and Norgate. 1863.

This work, which to biological inquirers who take an interest in the supreme question of Anthropological science—the origin of man, and the probability of his derivation from an inferior form—will prove a source of the deepest possible study and examination, is now published. It has so many points of similarity with the volume of Sir Charles Lyell on a cognate subject, that we shall prefer to discuss in a future number the whole question of man's antiquity. In the meanwhile we select a few of the passages by which Prof. Huxley advocates those conclusions to which he has been led during the past few years.

The work is divided into three essays: 1, the Natural History of the Man-like Apes; 2, the Relation of Man to the Lower Amimals; 3, the Fossil Remains of Man. As the criticism of the first two essays does not fall within the sphere of the 'Geologist,' we shall confine our remarks to the third essay.

It was Prof. Huxley's object "to show, in the preceding essay, that the *Anthropini*, or man family, form a very well-defined group of the Primates, between which and the immediately following family, the *Catarhini*, there is in the existing world the same entire absence of any transitional form or connecting link, as between the *Catarhini* and *Platyrhini*."

He confines himself in his remarks to the consideration of the skulls from Engis and the Neanderthal, and endorses the conclusion of Sir Charles Lyell, that the former "belonged to a contemporary of the mammoth (*E. primigenius*) and of the woolly rhinoceros (*R. tichorhinus*), with the bones of which it was found associated;" and that the Neanderthal skull is of great, though uncertain antiquity. Whatever may be the geological age of the latter skull, he conceives it is quite safe (on the ordinary principles of palæontological reasoning), to assume that the former takes us to, at least, the "further side of the vague biological limit, which separates the present geological epoch from that which immediately preceded it. And there can be no doubt that the physical geography of Europe has changed wonderfully since the bones of men and mammoths, hyænas, and rhinoceroses were washed pell-mell into the cave of Engis."

The description of the discovery of the Engis bones by Dr. Schmerling, as well as Prof. Huxley's notes thereon, follow. With respect to the Neanderthal skeleton, Prof. Busk's translation of Schaaffhausen is quoted at length. In Prof. Huxley's original observations he describes two beautiful photographs which he had received from Dr. Fuhlrott, the first of which demonstrates the great extension of the thickened supraciliary ridges beyond the cerebral cavity, and exhibits the wide openings of the frontal sinuses upon the inferior surface of the frontal part of the skull, into which, according to Fuhlrott, a probe may be introduced to the depth of an inch; and the second "exhibits the edge and the interior of the posterior, or occipital part of the skull, and shows very clearly the two depressions for the lateral sinuses, sweeping inwards towards the middle line of the roof of the skull, to form the longitudinal sinus." Prof. Huxley concludes that the posterior lobe of the brain of the Neanderthal man was exceedingly flattened and depressed, and that the posterior cerebral lobes must have projected considerably beyond the cerebellum.

After dilating at length on the varied forms of the human cranium, on which Prof. Huxley offers some most valuable remarks, he arrives at the conclusion that no comparison of "crania is worth very much that is not founded upon the establishment of a relatively fixed base-line, to which the measurements in all cases must be referred," such base-line being drawn through the centres of the basioccipital, basisphenoid, and presphenoid bones respectively. Examples are given of this mode of comparison.

Professor Huxley, we think rightly, declines to decide whether the Engis and Neanderthal skulls were more or less prognathous than the lower existing races of man, and turning to the Engis skull, he says, "I can find no character in the remains of that cranium which, if it were a recent skull, would give any trustworthy clue as to the race to which it might appertain. Its contours and measurements agree very well with those of some Australian skulls which I have examined, and especially has it a tendency towards that occipital flattening, to the great extent of which, in some Australian skulls, I have alluded. But all Australian skulls do not present this flattening, and the supraciliary ridge of the Engis skull is quite unlike that of the typical Australian. On the other hand, its measurements agree equally well with those of some European skulls, and assuredly, there is no mark of degradation about any part of its structure. It is, in fact, a fair average human skull, which might have belonged to a philosopher, or might have contained the thoughtless brains of a savage."

"The case of the Neanderthal skull is very different. Under whatever aspect we view this cranium, whether we regard its vertical depression, the enormous thickness of its supraciliary ridge, its sloping occiput, or its long and straight squamosal suture, we meet with apelike characters, stamping it as the most pithecoid of human crania yet discovered. But Professor Schaaffhausen states that the cranium, in its present condition, holds 1033·24 cubic centimetres of water, or about 63 cubic inches, and as the entire skull could hardly have held less than an additional 12 cubic inches, its capacity may be estimated as about 75 cubic inches, which is the average capacity given by Morton for Polynesian and Hottentot skulls. So large a mass of brain as this would alone suggest that the pithecoid tendencies, indicated by this skull, did not extend deep into the organization, and this conclusion is borne out by the dimensions of the other bones of the skeleton, given by Professor Schaaffhausen, which show that the absolute height and relative proportions of the limbs were quite those of a European of middle stature. The bones are indeed shorter, but this, and the great development of the muscular ridges noted by Dr. Schaaffhausen are characters to be expected in savages. The Patagonians, exposed without shelter or protection to a climate possibly not very dissimilar from that of Europe at the time during which the Neanderthal man lived, are remarkable for the stoutness of their limb bones. In no sense, then, can the Neanderthal bones be regarded as the remains of a human being intermediate between man and the apes. At most, they demonstrate the existence of a man whose skull may be said to revert somewhat towards the pithecoid type, just as a Carrier, or a Pouter, or a Tumbler, may sometimes put on the plumage of its primitive stock, the *Columba livia*. And indeed, though truly the most pithecoid of known human skulls, the Neanderthal cranium is by no means so isolated as it appears to be at first, but forms in reality the extreme term of a series leading gradually from it to the highest and best developed of human crania. One the one hand, it is closely approached by the flattened Australian skulls of which I have spoken, from which other Australian forms lead us gradually up to skulls having very much the type of the Engis cranium; and on the other hand, it is even more closely allied to the skulls of certain ancient people who inhabited Denmark during the 'stone period,' and were probably either contemporaneous with or later than the makers of the 'refuse heaps' or 'Kjökkenmöddings' of that country. The correspondence between the longitudinal contour of the Neanderthal skull and that of some of those skulls from the *tumuli* at Borreby, very accurate drawings of which have been made by Mr. Busk, is very close. The occiput is quite as retreating, the supraciliary arches are nearly as prominent, and the skull is as low. Furthermore, the Borreby skull resembles the Neanderthal form more closely than any of the Australian skulls do, by the much more rapid retrocession of the forehead; on the other hand, the Borreby skulls are all somewhat broader, in proportion to their length, than the Neanderthal skull, while some attain that proportion of breadth to length (80: 100) which constitutes brachycephaly."

"In conclusion, I may say that the fossil remains of man hitherto discovered do not seem to me to take us appreciably nearer to that lower pithecoid form, by the modification of which he has probably become what he is. And considering what is now known of the most ancient races of men,—seeing that they fashioned flint axes, and flint knives, and bone skewers, of much the same pattern as those fabricated by the lowest savages at the present day, and that we have every reason to believe the habits and modes of living of such people to have remained the same from the time of the mammoth and the tichorhine rhinoceros till now,—I do not know that this result is other than might be expected."

"Where, then, must we look for primæval man? Was the oldest *Homo sapiens* pliocene or miocene, or yet more ancient? In still older strata, do the fossilized bones of an ape more anthropoid, or a man more pithecoid, than any yet known, await the researches of some unborn palæontologist?

"Time will show. But in the meanwhile, if any form of the doctrine of progressive development is correct, we must extend by long epochs the most liberal estimate that has yet been made of the antiquity of man."

Such are a few of the more interesting passages which we have selected from Professor Huxley's work. The subject has been discussed in the 'Geologist' frequently during the last two years,* and we have no doubt that the publication of Professor Huxley's work, although it appears late in the month of February, will not fail to arouse the attention of geologists and anthropologists.

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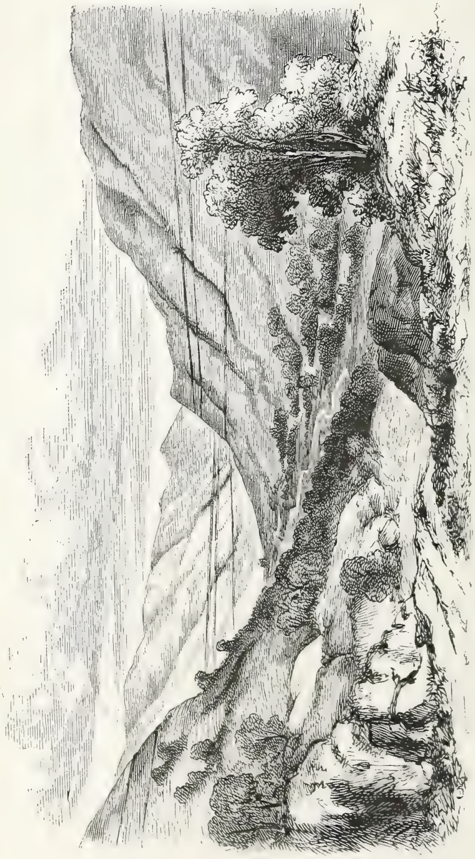
* Vol. iv. (1861), p. 396; vol. v. (1862), pp. 187, 201, 205, 303, 313, 314, 424, etc.

PLATE VII.



VIEW IN GLEN ROY, SHOWING THE PARALLEL ROADS, TAKEN FROM GLEN FINTEC.

S. J. Mackie del.

THE GEOLOGIST.

APRIL 1863.

THE PARALLEL ROADS OF GLEN ROY.

By the Editor.

On each side of a long, hollow, deep valley, bounded by dark and lofty mountains, at elevations respectively of 1266, 1188, and 980 feet, three strong lines are traced on the mountain-sides, parallel to each other and to the horizon, and at levels exactly corresponding on the opposite slopes,—so extraordinary in their appearance as to impress the most unphilosophical and incurious spectator.

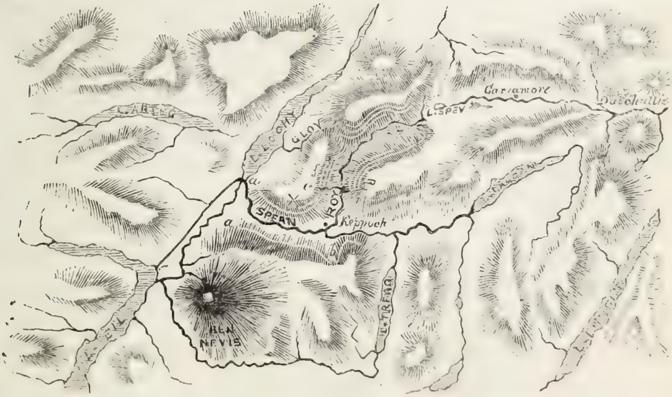


Fig. 1.—Map of the Glen Roy district. *a a′*, probable glacier-barrier; ⚔, Meal Roy, battle of the Macintoshes and Macdonalds; *f*, Glen Fintec; *x*, Glen Gastric; *t*, Glen Turit. The white lines indicate the "Parallel Roads."

These singular and solitary phenomena, although long known and celebrated by the Highlanders of that wild region as the traditional works of their great ancestors, remained unnoticed by science and the world at large, until that indefatigable disturber of hidden mysteries, animals, and antiquities, the tourist Pennant, published in 1769 a short account of Glen Roy, in his 'Tour through England, Wales, and Scotland.'

A second description appeared in the 'Statistical Survey of Scotland,' in 1793.

The subject was next taken up by Macculloch, who published an admirable paper, illustrated with views, maps, and sections, in the Transactions of the Geological Society for 1817. "So rarely," he remarks, "does nature present us in her larger features with artificial forms or with the semblance of mathematical exactness, that no conviction of the contrary can divest the spectator of the feeling that he is contemplating a work of art,—a work, of which the gigantic dimensions and bold features appear to surpass the efforts of mortal powers. We cannot wonder therefore that the solitary and poetical Highlanders, educated under mountain storms, and hourly conversant with the sublime appearances of nature, should attribute to the ideal and gigantic beings of former days, a work which, scorning the mimic efforts of the present race, marches over the mountain and the valley, holding its undeviating course over the impassable crag and the destroying torrent." But however convinced the Highlander may be that these "parallel roads," as they are called, were the works of Fingal and the heroes of his age, philosophers hold different opinions respecting them, and different opinions indeed they are that they themselves do hold. One attributes them to water, another to ice, and another to a cataclysmal wave surging and resurging over the Scotch mountains from the Atlantic. The matter was a disputed one amongst philosophers when Macculloch wrote, six-and-forty years ago; and just as he reviewed what others had thought before him, and added far better information of his own, so Mr. Jameson (the newly appointed lecturer on Agriculture in the University of Aberdeen) has recently investigated these natural curiosities afresh, and added much and most valuable information of his own.

Macculloch's description of the Glen Roy district and the "parallel roads" is very intelligible, and his suggestion that the latter were water-formed by standing water, was undoubtedly right, although the science of geology was not then sufficiently advanced for him to work out the whole subject to its issue. What he saw however he faithfully described. He begins with the source of the river, "or rather at the commencement of the valley, since the rivers, which form the Roy, rise in mountain-torrents, forming a junction in the middle of the valley." A low hill of granite skirts the boundary between the source of the Spey and the valley of the Roy. At the foot of this hill, in slightly elevated boggy plains, is found Loch Spey, the water from which, by a declivity for some time scarcely perceptible, runs eastward through Badenoch to fall into the Moray Firth. The western end of the boggy plain stretches for a few hundred yards beyond the head of Loch Spey, and then descends by a sudden step into the upper valley of Glen Roy. This valley is of oval form, about four miles in length, and one or more in breadth, being bounded on opposite sides by very high mountains. From these descend two streams, which unite about the middle of the valley to form the Roy. From this junction the water flows with a moderate velocity for the space of two miles, when the Glen suddenly contracts and terminates in a rocky hill of low elevation. The water, forcing its way for some distance through a narrow pass between approaching rocks, enters a second glen—the lower Glen Roy. It is in this latter that the "roads" are chiefly seen; nor on entering the upper from the lower glen would it be suspected that any similar appearances existed in it. A line however may be observed on the glen-side extending from the junction, which forms the Roy along the face of a low hill towards the elevation in which Loch Spey lies. "A careful examination of this line by spirit-level shows it to consist of a level narrow terrace, which, if prolonged eastward, would cut the perpendicular above Loch Spey, and if continued westward, would meet the summit of the flat rock that forms the division between the higher and lower Glen Roy." This summit is on a level with the uppermost of the lines in the lower glen, the terrace being in fact a prolongation of that line. No other terrace or line is found in the upper valley. . . . Wherever the natural rock comes to light, these

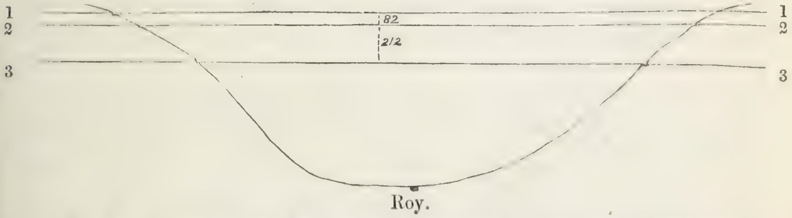


Fig. 2.—Section of Glen Roy, showing the contour and the levels of the three "parallel roads," 1, 2, 3.

marks or lines are least discernible, being of much smaller dimensions, and having a much greater conformity with the natural slopes of the hill. Whatever loose matter occurs here consists of large fragments from the hills above; the natural rock projects in many parts of the lines so as to interrupt them, or they are wanting whenever a solid mass of rock occurs in their course. Independently of the principal lines, short indistinct traces of others are to be met with. Proceeding down the glen, a river enters on the left, equal in size to the Roy, and falling into it by a cascade over a rocky bed. Here a large series of terraces are found, forming a large *terre-plein* at top of this lower glen. These terraces are of different levels, as may be seen in the section and view accompanying this paper. The highest of these is on a level with the third principal "road." Successive stages of terraces descend to the bed of the river, the bottom of the glen being an alluvial flat. The general breadth of the "roads" is about sixty feet. Two glens, Glen Turit and Glen Fintec, open into Glen Roy, and on the sides of these "roads" are also seen. It is near the opening to Glen Turit, that the third or lowermost line is first seen. The following heights are given with others, by Macculloch, approximately by barometric measurements:—

Upper line ("parallel road") of Glen Roy above the Western Sea at Loch Eil	1262
Above the German Sea	1266
Lowest line of Glen Roy above the Western Sea	976
Upper line above land at Loch Oich	1180
Lowest line above land at Loich Oich	886
Upper line above the second in Glen Roy	82
Second line above the lowest in Glen Roy	212
Upper line of Glen Roy above the junction of the Roy and Spean	927
Lowest line of Glen Roy above the junction of the Roy and Spean	633
Upper line of Glen Roy above Loch Spey	63
Upper line of Glen Gloy above the Western Sea	1274
Difference above highest of Glen Roy	12
Bottom of Glen Roy at upper end above its bottom at the junction of the Roy and Spean, or its declivity	644
Height of Loch Spey above the German Sea	1203

On the left bank of the Spean, near the junction of the Roy, a *line* is visible, corresponding to the lowermost line of Glen Roy. It runs about three or four miles, but no corresponding line is found on the right bank on the Spean. It finally disappears opposite to Teindrish, where the valley is so wide that the opposite lines are four miles asunder. Glen Turit is at so great an elevation where it enters Glen Roy, as to exclude the two lower lines; but forms a connection between Glen Roy and Glen Gloy, rising between the two and discharging its waters on both sides. It is important, Macculloch continues, to notice that although the opposite sides of Glen Turit are very little dissimilar either in shape or composition, they do not equally exhibit equal traces of the "roads."

Glen Roy itself opens by a wide mouth, varying from five to seven miles, into the great valley which stretches from the northern to the western sea; the whole of this space is uneven and hilly. Applying the spirit-level to a great many points, Macculloch found them inferior to the lowest "road" of Glen Roy, with one or two exceptions. The opening of Glen Gloy is narrow. By a comparison of heights, Macculloch found that Loch Laggan to the east is depressed 369 feet below Loch Spey, and 432 feet below the uppermost "road" of Glen Roy. Supposing therefore that the water stood at the highest elevation in Glen Roy in the present state of the earth "it would run into the Spey not only by the channel of Loch Spey, but by that of Loch Laggan also." For these singular roads, Macculloch offered (1817) the ingenious solution that they had been formed by the waves, or littoral action of standing water. "The absolute water-level," he says, "which is found to exist between the corresponding *lines* both in Glen Roy and in those valleys which communicate with it, admits of a ready solution on the supposition that a lake once occupied this set of valleys; nor can it be explained on any other. As a free communication in one direction at least still exists among them, it would even now be easy to imagine the water replaced in the same situation; the difficulty of confining it will be a subject for future consideration. If, however, a lake be considered the cause, it is plain that the *lines* in question were once the shores of the lake; and it equally follows that it had existed at three different elevations, and that the relative depths of these three accumulations of water may be measured by the relative vertical distances of these three lines from the bottom of the valley. Thus the nature of the retaining obstacles becomes more complicated, and adds materially to the difficulties."

Having compared all the appearances of Glen Roy with those which are found in existing lakes, and considered the probable changes which the drainage of such lakes would effect on these containing-valleys, he proceeds to point out the difficulties with which even this hypothesis is encumbered.

"It has been seen," he says, "that considerable deficiencies may be observed in the courses of the 'lines,' as well in Glen Roy itself as in the neighbouring glens. Some of these anomalies indeed assist in proving the probability of the hypothesis; . . . the remainder, yet unaccounted for, may perhaps be explained hereafter. . . . One short 'line' only is found in the upper valley of Glen Roy; yet all the sides exhibit a general equality of slope, form, and texture; nor is any side more than another, subject to the action of a visible wasting cause. A great deficiency of the whole of the 'lines' occurs also towards the bottom of lower Glen Roy, and many partial ones in other places. Of these, some evidently arise from the rocky nature of the margin; and others may perhaps be the consequence of the coincidence between the slope of the hill and the slope of the supposed shore. But these causes will not account for them all; nor are there sufficient marks of the action of posterior waste to explain them. The anomalies of Glen Roy and Glen Spean in particular . . . seem at present to baffle all explanation, and in this unsatisfactory state must the argument remain. It were well if there were not further difficulties to encounter in adopting this hypothesis, but it is necessary to enumerate them. . . . As the level of the upper 'line' of Glen Roy is higher than those of many valleys which would at present afford passage to the supposed waters of Glen Roy into the sea, it follows that water could not now stand at that level unless these apertures were obstructed to at least a higher elevation. The determination of the position of these imaginary barriers is consequently the next point to be considered; as well as that of their number, since possibly two of these openings might be closed by a single obstruction." . . . "The uppermost one is of such a height that the water standing at that level would now flow out by Loch Spey and Loch Laggan, through the valley of the Spey, into the eastern, and by Loch Eil, Loch Sheil, and Loch Ness into the western sea. The two lower 'lines' lying below the barriers of Loch Spey and Loch Laggan, it would, under similar circumstances, find its way through the three latter openings only. The condition of the surrounding land must therefore have so far differed at that time from its present state, that various dams or barriers must have existed in the course of these openings. . . . The conditions of the present barriers existing at the source of Loch Spey and to the east of Loch Laggan, are such as to give no reason to imagine that they have once been higher. . . . By the removal of the supposed barriers to a point below Dalchully, one obstruction would . . answer . . . the purpose of confining the waters in this direction. If this were a mass of alluvial matter occupying the strath in which the junction of the Spey and the Truim takes place, it is not difficult to conceive that it was worn down by the action of the waters of the Spey, causing the drainage of the highest level in Glen Roy; or else after that drainage had taken place by the failure of some other barriers. The flow of the Spey and the Roy would then follow the directions of the intermediate ground, and the present courses of these rivers, as far as they were then free, would be established. If we now turn to the western side of Glen Roy, and examine the elevation and direction of the ground at its junction with the vale of the Lochy, we shall see that both Glen Roy and Glen Spean bear one common water-mark or 'line,' and unite in one common wide valley before they join the vale of the Lochy. The imaginary barrier must therefore be removed at least to that part of this valley where the 'lines' terminate, which is to a point beyond Teindrish. . . . But the form of this ground and the gradual dilation of the valley into that of the Lochy is such that no barrier could have existed here without occupying the whole of the present valley of the Lochy." Macculloch therefore proposes to remove this barrier to an indefinitely distant point towards the sea.

"If . . . Glen Gloy was dammed by a barrier of its own, independently of that which occupied . . . the common opening of Glen Roy and Glen Spean, we multiply our difficulties without necessity. A continuous lake must therefore be supposed to have existed among the present valleys of the Roy, the Spean, the Gloy, and Loch Lochy, independently of a portion of Strathspey." Macculloch then gives a map of the quantity of water he presumes under these circumstances must have occupied the surrounding country, but the positions he assigns to the barriers, and the condition he depicts for the country, are not entirely such as the glacier theory, hereafter to be noticed, will require. A considerable portion of Glen Lochy must therefore, he thinks, have formed a part of this common lake, and although he cannot determine its boundary in this direction, it must, according to his views, have extended at least to the north of the opening of Glen Gloy. But that valley opening into what would have been the middle of this lake, and being constantly diminished from the deposit of alluvial matter from the streams, while the permanence of the 'lines' upon the hills shows that they have undergone no violent changes, Macculloch does not incline to put any barrier there. If he attempts the great Caledonian valley, he gets entangled in a series of similar difficulties; in short, he does not find it possible to "fix upon a point which shall satisfy the requisite conditions." He then tries the lower end of Loch Lochy, which terminates in a wide alluvial plain; and urges that if any probable place can be selected here for the barrier, it is "at the narrowest part of the opening which lies at Fort William, between the skirts of the range below Ben Nevis and the opposite heights of Ard Gowar." He then refers necessarily to the other free opening which exists for the supposed lake through Loch Shiel and Loch Moidart. Another barrier must therefore be interposed in this direction; and thus there will be formed a large lake occupying Glen Roy to some point beyond the present course of the Spey and Glen Spean, with the whole of Loch Laggan and Glen Gloy, the great Caledonian valley, from a point of which he does not pretend to define the northern limit, to Fort William; Loch Arkeig and a part of the valley which includes it, and finally the western valley of Loch Eil to some undefinable point lying towards Loch Moidart and the western sea. The whole of this limit, he admits, is not demonstrable, but he considers the similarity, if not the actual community, of the "lines" of Glen Roy and Glen Gloy demonstrates that a portion or the whole of Loch Lochy was included in it.

Here, therefore, a serious difficulty arises. This is the total absence of all corresponding watermarks on the borders of Loch Lochy, as well as on the principal extent of the borders of Loch Laggan and the valley of the Spean. There is a set of common features through the whole tract,—the same rocks, the same slopes, the same causes of waste; yet the watermarks are strongly defined through a portion of this wide space, while they are totally wanting in others. The complete and sudden transition from the uppermost line of Glen Roy to the next succeeding one, and finally to the present bottom of the valley, shows a perfect draining of the whole. Macculloch thinks that the lake which occupied these valleys subsided at three different intervals; and further, that the more probable supposition is, that these three drainings took place at the same point; and he assumes it most convenient to take the present and lowest communication,—the exit of the water of the Spean and Roy as that point. "Here then," he says, "we must imagine a dam has existed, not gradually worn down by the slow corroding action of the river issuing from the lake, but by three successive failures occurring suddenly, or at least within short intervals of time. Had much time elapsed between these intervals, the several lines must have been more obscurely marked, or intermediate ones of smaller dimensions must have been visible. . . . Admitting, then, that the corroding action of the waters of the Spean and Roy, operating on an alluvium at the exit of the Lochy, had, by destroying a portion of the barrier, discharged that portion of the lake which stood above the second line of Glen Roy, a vertical distance of 82 feet, we have still left standing the other barriers, of the existence of which we cannot doubt, although their places cannot be precisely assigned. By what operation, then, were these lowered? If by any causes of a nature similar to those which we see in daily action on the surface of the earth, it must have been by the flowing of rivers upon them. Thus the flow of the Ness and the Spey towards the sea might have lowered the land in these directions to their present level, and thus the exit of Loch Shiel might have destroyed the barrier to the west; while the repeated failures of the supposed barrier at the mouth of the Lochy had, in the meantime, produced the complete drainage of Glen Roy and Glen Gloy, and, with the exception of Loch Laggan, that of the Spean."

Macculloch himself felt the difficulties he had to contend with, and these he puts forward so openly, so honestly, and so undisguisedly, that we feel that his facts at least are carefully-gathered truths, and that we can depend upon them. "I know not," he frankly says, "that the direct arguments which have been here stated are sufficient to prove that hypothesis, respecting the 'lines' of Glen Roy, which appears to be the best founded; or whether, combined with these indirect ones, which prove the impossibility of the two others, and the high improbability of the third, they may be held sufficient to establish its truth. I have, however, shown that although it still labours under unexplained difficulties, no physical impossibility is in any way opposed to its superior probability; we may therefore admit its claim for the present, at least so far as to justify us in examining the geological consequences likely to result from it."

Moreover, Macculloch distinctly saw that the causes he had assigned for the appearances in Glen Roy were attended by consequences materially affecting the notions which had been, with every appearance of reason, entertained relative to the ancient state and posterior changes of the great Caledonian valley. "It is conceived," he says, "by many persons that Scotland was once entirely or partially divided in this place by the sea, the highest elevation of the present land being 90 feet. By the constant descent and accumulation of alluvium from the mountains, it is supposed that the dams have been formed which now separate Loch Oich both from Loch

Ness and Loch Lochy, while these lakes have been disjoined from the sea by the large alluvial plains that now extend from them at each end, along the courses of the Lochy and the Ness. The operations required in constructing the Caledonian Canal have ascertained the reality and extent of these alluvia, while daily observation shows that they are in many places at least receiving an augmentation, that has a tendency at some far distant period to obliterate the lakes and convert the whole into one prolonged strath, of which the future summit will be Loch Oich or some point in its vicinity. If, indeed, we examine the changes which the lakes of Scotland are now undergoing, we shall find that they are receiving accumulations of alluvial matter at all the points where they are fed by the surrounding streams, while a comparatively small quantity of this alluvium is carried towards the sea. The result of this operation is to obliterate them and to convert them into alluvial valleys or straths. Instances of this revolution, more or less perfected, are numerous; while no case of the obliteration of a lake by drainage, similar to that of Glen Roy, can be pointed out."

But it is at this point of his argument that Macculloch encounters the most serious objection to his theory; not that that theory, as far as the ancient existence of a lake in the Glen Roy region is concerned, is erroneous; not that he was wrong in attributing to the action of the standing water of that lake, the erosion of the "parallel roads" of that and the neighbouring glens; but the difficulty existed in finding some natural way of constructing and in accounting by known physical causes for the total demolition of the barriers, considered as barriers of earth, whether of rock *in situ* or of accumulated alluvia. He feels this difficulty acutely, it is evident, for although he may be said to have completed his subject, he still goes on, through a dozen quarto pages, to comment on the difficulties of this position and to offer explanations. "It is not, however, inconceivable," he says, "that the causes which are now, by the accumulation of alluvium, obliterating the existing lakes, should, under some variation of ground, have heaped a barrier on the course of a valley, and generated at one period a lake which they were afterwards destined to destroy, or which, accumulating strength by confinement while the opposed barrier was undergoing a slow waste, should suddenly break its bounds and again desert the valley which it had been previously compelled to occupy"

This, however, is an argument which carries its own conviction of fallacy, because the causes which were in operation to form a barrier of alluvial matter could not be at the same time causes of destruction. If any causes were in action capable of forming a barrier of fine earthy deposit to the height of 927 feet above the bottom of Glen Roy, the same causes could not possibly act, at the same time, in producing "a slow waste" in the opposing barrier. Besides, taking the opposite view, that the lake, by the accumulation of its water pent in by the barrier, acquired weight enough to burst it, what has become of the remains of such a gigantic mound? It could not have been washed away totally, and not have left a wreck behind. Macculloch's acute mind saw, too, the difficulty of removing the other earth-barriers, which must have remained after the breaking down of this one; "and other causes," he adds, "which we know not where to seek, must be found to explain the removal of alluvia from points where they appear at present to be, on the contrary, accumulating."

Such in the main are the natural features presented by Glen Roy; and such the excellent views put forward by Macculloch. That the "parallel roads" have been formed by water action, and are in point of fact ancient lake-shores, few are or have been much inclined to doubt. But the difficulty has been, as we have said, to find the barriers which held up the lake. Macculloch lived before these days of glacial theories, and he looked for a solid barrier of rock or earth; and it was naturally considered that if such a barrier had existed, some traces of its ruins should remain. Agassiz, some years since, suggested the possibility of the Glen having been blockaded by glaciers, but did nothing towards proving the case beyond giving out that suggestion.

Glacier-action, however, would eliminate all these incongruities from Macculloch's theory. A wall or barrier of ice would melt away and leave comparably to a bank of earth but very little trace indeed; this is the point Mr. Jamieson has taken up to investigate. Sir Charles Lyell has referred to the parallel roads of Glen Roy, and to Mr. Jamieson's previous labours in that region, in his recent work 'On the Geological Evidences of the Antiquity of Man,' but since the labours there referred to, Mr. Jamieson has communicated a valuable memoir on the subject to the Geological Society of London, of such importance that it must attract attention whenever it is published in the Society's Journal. In it he gives the proofs of ancient ice-action which he has met with in the district, and even assigns the places of the glacier-barriers; but, if we understand his meaning rightly from the portions of his paper read, he seemed to retain Macculloch's idea of a *deep* lake behind this ice-barrier.

In this we differ in opinion; hence the reason of our taking up the subject in this article. In the discussion which followed the reading of Professor Jamieson's paper, a great many valuable comments were made. Mr. Gwynn Jeffreys confirmed Mr. Jamieson's opinion of the relationship in time of the "parallel roads" to the great submergence in the Drift period,—namely, that the "parallel roads" were of more recent date,—and stated that in the "forty-feet beach," out of forty species of shells, three quarters of the number were Boreal forms, and one quarter Arctic, and that this beach was more recent than the Clyde beds, the shells in which were all of Arctic form. Mr. Mallet seized, with his characteristic astuteness, upon the difficulty of a deep lake being retained by a barrier of ice. He made some very excellent remarks upon the formation of the roads by lake-waves, and on the differences of lake-beaches and sea-beaches in respect to the curves and heights of the slopes formed by the shallow waves of the one, and deep waves of the other; but he appeared to us to go all wrong in his objection to the existence of an ice-barrier, by contesting that the ice being of less specific gravity than the water, the water of the lake would float and overturn the barrier,—an utter misconception, we conceive, of the case, which would have been better put by making reference to the absolute weight of the ice-barrier; for it is evident that the *lifting*-power of the lake water would be in proportion to its *depth*, and that for an object to be floated from *one side* the efficient raising power of the water must be got by doubling the height necessary to float the whole mass from both sides. Now, as the specific gravity of ice is to water as ·920 to 1·000, it is evident that the height of the water must be at least $\frac{8}{10}$ths higher than the barrier to be floated, and which kept it back. How then was the water retained on the one side, at such an elevation above that of the lip of the barrier itself?

If we conceive the whole region filled with glacier-ice, and that at a period when the climatal conditions had changed from the intense cold of the glacial era to a much milder temperature,—as is shown to have been the case, if the "roads" are subsequent to that epoch, by the proofs of amelioration of temperature at the period of the "forty-feet beach," shown in the increase of Boreal and the diminution of Arctic shells,—it is evident we must have had the formation of the roads taking place at a period of *thaw*, and therefore there might have been a comparatively shallow lake, caused by the water of the melted ice sustained in the hollowed surface of the glen-glaciers. The gradual melting of such glaciers would cause a weakening of the retaining barriers of the glacier-lake, and sudden débacles might occur; or the streams which now run through the glens may have been originally streams issuing at the feet of the glaciers, and cutting out the valleys beneath them; such streams do undermine glaciers, and when the collapse of the ice into the cavities or its launch forward took place, the lake on the summit might be discharged, or it might be merely and placidly slipped down to a lower level without any or with only a trifling discharge of its waters.

It might be, moreover, that the melting of the ice of the remains of glaciers at a higher level than the surface of this lake, caused a continual flow of the water of the lake, and gave it a cutting-power in addition to its wave-action.

At any rate, it seems more possible, as well as more probable, that the lake was a glacier-supported accumulation of water, than that a great barrier of ice should be erected in front of a body of water to shut it back. On the other hand, if the glacier were formed across an open plain, where was the water to form the lake to come from? The supposition, therefore, that the lake was formed by the melting of the glacier, and was held up on its hollow summit, appears to avoid some difficulties to which even the glacier theory of the origin of these singular roads is open.

ON A NEW FISH-JAW FROM THE GAULT NEAR FOLKESTONE.

By C. Carter Blake, Esq.,

Honorary Secretary to the Anthropological Society of London, and Lecturer on Zoology, London Institution.

My friend Mr. Mackie has handed me an interesting little fragment of jaw, derived from the Gault at Folkestone. The length of the broken fragment of jaw measures $1\frac{1}{8}$ inch; its absolute breadth $\frac{2}{8}$ of an inch. It contains three teeth, of which the largest is conical, incurved, exhibiting around its thickened base a series of sculptured linear depressions, parallel with the axis of the tooth, the interior of which has been converted into phosphate of lime; the second and the third also exhibiting similar characters, the third especially being acuminate, and exhibiting the natural apex of the tooth in an uninjured state. The conformation of such a tooth led my friend

Mr. Davies to compare it with the homologous structure in the teeth of the *Pachyrhizodus basalis* of Agassiz, which is described by Sir Philip Egerton, F.R.S., in Mr. F. Dixon's 'Geology of Sussex.' The specimen figured in that work was obtained from the Lower Chalk at Steyning. The characters, which are given, are—"apex very brittle, slightly curved inwardly, and solid; the base is hollow, and extends into the substance of the jaw." It is further stated that in Sir Philip Egerton's cabinet there is a specimen of this fish, exhibiting an unusually thick and strong humerus, as well as large and circular scales, covered with asperities so minute as to be indistinguishable without the aid of a glass.

There are many points of distinction, however, between the *Pachyrhizodus basalis* of Agassiz, and Mr. Mackie's specimen. Apart from the absolute size of Mr. Dixon's specimen, which is at least double that of the one before me, I am wholly unable to detect in the former any trace of that curious sculptured channelling which is so prominent in the latter specimen. This comparison failing, Mr. Davies showed me some most interesting specimens, also from the Folkestone gault, which exhibited equally perfect evidences of this sculpturing. I would therefore suggest that some temporary or provisional name should be given to this form, which differs from the *Pachyrhizodus basalis* of Agassiz, both in its stratigraphical habitat and its odontological conformation.

The genus Pachyrhizodus, of which comparatively so little is known, has been included in the family Sphyrœnoida, of the great division of Acanthopterygian (Cycloid) fishes, in close proximity to such singular aberrant forms as Saurodon and Saurocephalus. We hope that the day is not far distant when some practical ichthyologist may be induced to examine the whole series of sauroid fishes, with a view to their ultimate division into precisely determined families.

PACHYRHIZODUS GLYPHODUS, *Blake and Mackie.*

Spec. Char.—Teeth with longitudinal rows of deep sculpturing, parallel with the dental axis.

CORRESPONDENCE.

Glytolepis, Dura Den (Keuper Breccia).

DEAR SIR,—In claiming precedence for Mr. Robert Walker as the first to make public the fact that *Holoptychius Flemingi* belonged to the genus Glyptolepis, I ought to explain that this only applies to making it known in this country. Professor Pander, in his monograph on the Saurodipterini, stated his belief that the scales supposed to belong to *Platygnathus Jamesoni* and *H. Flemingi* of Agassiz, were in reality the scales of *Glyptolepis leptopterus*. The Professor's only mistake in this being that those scales belonged, not to *G. leptopterus*, but to a distinct species of Glyptolepis, which may be called *G. Flemingi*.

It may also be of interest to some of your readers to be informed that

I lately observed the "bone breccia" or "osseous conglomerate" of the Upper Keuper Sandstone, which I described some years since in a paper read before the Geological Society of London.

It is exposed in a railway cutting at the village of Ripple, between Upton-on-Severn and Tewkesbury, and contains the remains of spines of *Lophodus (Acrodus) minimus* in great abundance. I also recognized portions of *Ceratodus cloasinus*, of Quenstedt, with scutes and other fragments of the bones of Labyrinthodon. It is the richest Keuper-bed I know of in England, and well worthy the attention of all collectors of fossils. Henry Brooks, of Ledbury, would be a good guide to the place, and knows the bed which is so fossiliferous. I am, Sir, yours obediently, W. S. Symonds.

Pendock Rectory, near Tewkesbury, Feb. 26, 1863.

Holoptychius v. *Glyptolepis*.

Sir,—Mr. Powrie, in his communication in the last number of the 'Geologist,' says:—"The only species of Holoptychius on which I have never yet been able to detect scales showing the crescent of points is *H. Andersoni*." It may interest Mr. Powrie and others also, concerned in the question of Holoptychius *v.* Glyptolepis, to learn that the typical specimen of *H. Andersoni* described by Agassiz, and figured in his 'Vieux Grès Rouge,' pl. 22, f. 3, now in the British Museum collection, has the sculpturing of points, which Mr. Powrie has failed to detect in other examples of this species.

In confirmation of Mr. Powrie's statement that he has detected them on scales of all the other species which he has examined, I can state that they are present, and well developed, on the posterior scales of the fine typical example of *H. nobilissimus* from Clashbennie, and also on scales of most of the specimens in the national collection, referred to this genus, from Dura Den, Nairn, etc.; and they are discernible on one or two of the scales of the fragment of Platygnathus in the same collection.

So far as my own observation goes, the "crescent of points" is entirely absent on the scales of the anterior portion of the body, but becomes more and more developed as the scales recede backwardly—dorsal, lateral, and ventral—towards the posterior portion. But this particular sculpturing is by no means a new discovery; it was observed by the earlier describers of the genus; and among others Hugh Miller, in his 'Old Red Sandstone,' describes them as "an inner border of detached tubercles." And M'Coy, in his description of *H. Andersoni*, says that in all cases, the anterior part" (of the scale) "is occupied by a patch of rather coarse radiatingly disposed granules, from whence the ridges arise that go to the free edge." He intimates, also, that they are present in his *H. Sedgwickii*.

Without offering any opinion as to the distinctive generic value of this sculpturing, there is one noticeable character, which is mentioned by Mr. Mitchell,—the much less degree of imbrication of the scales of Holoptychius compared with those of Glyptolepis; the scales of the former consequently exhibit a greater exposed surface, and are not so numerous as in the latter genus. And whilst the scales of Glyptolepis are so very variable in form and sculpturing, according to their position on the body, "whence," says Professor Huxley, "arises such an amount of unlikeness, that different species might readily be founded on scales from different regions," the scales of Holoptychius, on the contrary,—with the exception of the presence or absence of the lines of points, and minor differences of sculpturing and size,—bear, in the general style of the bold wavy ridges of their exposed overlying portions, a character which there is no mistaking, no matter what their position. Yours truly,

W. Davies.

March 12, 1863.

The Rev. W. Allen's Letter on Portland Fissures.

Sir,—Will you allow me to say a few words on the subject of Mr. Allen's letter in your last number? If his suggestion be correct, how is it that animals of distinct *genera*, if not *species*, from any known to have inhabited Britain in historic times are found in the Middle and Upper Oolite? And, again, if he be right concerning the "Upper Oolite" of Portland, why may not the same have taken place with other geological formations *after* the Oolitic series? And this we know cannot well be, as those succeeding it must be far older than 6–7000 years. Is it not more likely that during the Pliocene period (when man is supposed to have existed), the "Upper Oolite" of Portland was submerged; and, as the remains of an extensive estuary (in Dorset and Hampshire) exist close at hand, may not the human remains referred to by Mr. Allen have been washed down to the sea and so deposited in the submerged strata, than that a fresh sedimentary deposit has taken place, and the whole formation have been again upraised, and rent almost throughout, perhaps by volcanic action? Hoping you will excuse these perhaps somewhat crude remarks,

I remain, yours truly,

Charles Jicks, Jun.

Woodlands, Thorpe, near Norwich, March 23.

Norway Horses.

Sir,—At p. 26 of the 'Geologist' is an inquiry about the teeth of Norway horses. Last autumn, in a Norwegian tour, a friend, Charles Montagu Doughty, Esq., picked up by the sea, and near the North Cape, the tooth of a horse—which molar I have forgotten. It had not the aspect of a fossil, nor was it very recent, but, as Mr. Doughty suspected before I saw it, was certainly *Equus fossilis*. Although I have often found on our own coasts teeth of *Equus caballus* in exactly the same state of preservation, this cannot be regarded as more than suggestive evidence of the existence of the fossil form, since horses are not now kept so far north.

I am, Sir, faithfully yours,

Harry Seeley.

Cambridge, March 9, 1863.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society.—*February* 18*th*. 1863.—"On the Middle and Upper Lias of the Dorsetshire Coast." By E. C. H. Day, Esq.

The subdivisions of the Lias instituted by Sir Henry de la Beche and

Dr. Buckland from stratigraphical considerations, and the subsequent modifications and further subdivision established by recent careful comparisons of the fossils having been briefly noticed, the author proceeded to define the two portions of the Lias which were treated of in this paper. The Middle Lias was stated to comprise all the beds between the zone of *Ammonites communis* above, and that of *A. raricostatus* below; and the Upper Lias to include the beds commencing with the zone of *A. communis*, and ending with that of *A. Jurensis;* or, all those resting on the zone of *A. spinatus*, and superposed by that of *A. Murchisoniæ*.—the beds formerly termed 'the Sands of the Inferior Oolite' being referred to the Upper Lias. The sections exposed at Black Venn, Westhay Cliff, Golden Cap, and Down Cliffs were described in succession, the fossils found in each bed being given, as well as the vertical range of the Ammonites.

The occurrence of a new genus of the Belemnitidæ in the Belemnite-beds of the Middle Lias was noticed, and a description of its general features given, with a list of the associated fossils.

Mr. Day then exhibited, in the form of a generalized section, the different Ammonite-zones into which the Middle and Upper Lias of the Dorsetshire coast could be divided, and gave lists of the fossils peculiar to each.

GEOLOGICAL SOCIETY.—*March* 4.—"On the Permian Rocks of North-Eastern Bohemia." By Sir Roderick I. Murchison, K.C.B., F.R.S.

The author, accompanied by Dr. Anton Fritsch, of Prague, made a transverse section of the rocks exposed by railroad-cuttings between Josefstadt on the S.S.E. and Semil on the N.N.W. These rocks, simply termed Roth-todt-liegende by the Austrian and Saxon geologists, are however of very varied mineral characters and of very considerable dimensions. They consist, in ascending order, of, 1st, coarse conglomerate and sandstone, followed by thin courses of schist, with fishes (Palæonisci, etc.), and interstratified igneous rocks (basaltic clinkstone, porphyry, etc.): 2nd, alternations of coarse grits and sandstone, with large Araucarites and other plants; and 3rd, of bituminous schists, in parts containing coal, with some layers of limestone, copper-slate, etc., and many fossil fishes in bituminous flagstone passing up into red-and-green-spotted sandstones and marls.

This series of rocks, though subject to local undulations, assumes at Liebstadtl a steady dip to the S.E., or away from the Riesengebirge: this is well seen on the railway between Liebstadtl on the S.E. and Semil on the N.W., which section was described by the author in detail. The igneous rocks, chiefly amygdaloids and porphyries (Melaphyr), occur at various horizons in the series, and are supposed to have been, for the most part, of contemporaneous formation with the regular aqueous sediments.

Alluding to the animal remains, as enumerated by Geinitz, the author stated that he was disposed to view the group as having chiefly an estuarine character, the various sauroid fishes and the coarse conglomerates leading to that inference; at the same time he admits that portions of it were probably freshwater and terrestrial accumulations. After pointing out the chief localities of the large fossil stems of the Araucarites and other plants, allusion was made to the opinion of Göppert and Geinitz, that the fauna of this group is, as a whole, distinct from that of the carboniferous age. He shows that the thickness of the whole of these rocks in Northern Bohemia is very considerable. At Erlbach, in the adjacent country of Saxony, the inferior half only of these deposits, or the lower Rothliegende, has actually been sunk through by a shaft, in search of coal, to the depth of 2300 feet, as brought to his notice by Professor Keilhau.

In referring to the general relations of these rocks, he suggests that, as they vary very considerably in different regions, they are best defined by the word Permian, which, according to its original definition by himself and his associates in Russia, simply means that such rocks lie between the upper coal, on which they rest unconformably, and the lowest portion of the Trias, by which they are covered.

It was observed that, in proceeding from north to south (in eastern Germany), the Zechstein thins out; and seeing the vast dimensions which the group assumes where true Zechstein is no longer traceable, the author suggests that some of the higher members of the Bohemian Rothliegende may represent that limestone *in time*. The term Dyas, recently applied to the whole Permian group by Geinitz, is objected to, since it is based on the theory that the lower portion of the Permian is exclusively of fresh-water origin, as contrasted with the superjacent marine Zechstein, and also because the geographical term Permian, involving no theory, had previously been widely adopted, and even used by Geinitz himself.

Sir Roderick having expressed his great obligations to Dr. Geinitz, to whose excellent work ('Dyas') he made many references, and to the name of which only he objected, concluded by presenting to the Society a very large collection of rock specimens of the Lower Permian of Saxony.

March 18.—1. "On the Correlation of the several Subdivisions of the Inferior Oolite of the Middle and South of England." By Harvey B. Holl, M.D., F.G.S.

The order of succession of the subdivisions of the Inferior Oolite observed in passing from the southern side of the Mendips to the typical section of that formation at Leckhampton, with the lithological characters of the strata, were described in this paper. The classification of the members of the Inferior Oolite employed by Mr. Hull in the Memoirs of the Geological Survey, was adopted by the author; and it was shown that in proceeding from Bath northwards, the two upper subdivisions may be seen to rise, the building-freestone at the same time becoming thicker, while at Aveling the Oolite marl is first seen interposed between the lower ragstone and the lower freestone, and at Nailsworth the former is separated from the Oolite marl by the upper freestone, all these beds becoming thicker towards Cheltenham, and thinner in the opposite direction, towards Bath. Dr. Holl concluded with some remarks on the strata exhibited in the Rolling Bank Quarry, and on the geographical distribution in England of the members of the Inferior Oolite.

2. "On the occurrence of large quantities of Drifted Wood in the Oxford Clay, near Peterborough." By Henry Porter, M.D., F.G.S.

The Oxford Clay in the neighbourhood of Peterborough having been exposed in clay-pits, the author was enabled to carry on some investigations regarding the fossils which there occur in it; he found the formation to be extremely rich in organic remains, and, besides containing many species of Ammonites and other Mollusca, which he enumerated, to include large quantities of drifted wood, the fragments bearing on their surface the impressions of Ammonites.

3. "On a new Macrurous Crustacean from the Lias of Lyme Regis." By Henry Woodward, Esq., F.Z.S.

A very perfect specimen of a Crustacean, obtained from the Lias of Lyme Regis by Mr. Harrison, of Charmouth, was described in this paper as the type of a new genus. The nearest living analogues were stated to belong to the fossorial group Thalassinidæ, from which it differs chiefly in its much less rudimentary abdomen, and the length of its chelæ. Amongst fossil forms, this Crustacean, which was named *Scapheus ancylochelis*, approached most closely to *Megacheirus longimanus*, from the Solenhofen limestone, species of which genus occur also in the Oxford Clay of Wiltshire and the Oolite and Lias of Germany.

The following specimens, presented to the Society's collection, were exhibited:—

A specimen of columnar brown coal from near the Basalt, Gross Almerode; presented by W. J. Hamilton, Esq., F.R.S., Sec.G.S.

A cast of a fragment of a tooth of Mastodon, from a gravel-pit at Swaffham; presented by C. B. Rose, Esq., F.G.S.

Geographical Society.—*February* 23*rd*.—"On the Discharge of Water from the Interior of Greenland, through Springs underneath the Ice." By Dr. H. Rink. The whole of Greenland may be calculated to be somewhat more than 300,000 square miles, and there is reason to suppose that a mountain range runs through it from north to south, dividing it into two portions. There being also reason to believe that this water-parting lies nearer to the east than west side, Dr. Rink assumes that 200,000 out of the 300,000 square miles discharge their waters into Davis' Straits and Baffin's Bay. Every glacier is a mountain river; the upper part, turned into ice, still continues to move, but this change cannot extend so far as to comprise all the water contained in the original river. Some part of it must continue to flow, in a liquid form, either on the top of the glacier or through channels underneath it. Wherever the inland ice reaches the sea, having a perceptible motion out into it, there is always observed a motion in the water, in front of the outer edge of the solid ice, like that of *large springs* issuing from the bottom. The water looks as if it were boiling or agitated by a whirlpool, and myriads of sea-birds are continually seen to hover about these spots, incessantly diving and snatching after food in the brackish water. But the most remarkable thing is, that a lake, lying close up to the ice at some distance from the sea, presents phenomena similar to those in the sea in front of the ice. The water in it rises and falls periodically. When it rises the neighbouring springs from the bottom of the sea are seen to decrease; on the other hand, whenever it falls, the springs increase. Dr. Rink thinks that these phenomena might be carefully observed at a large ice-fiord during the winter, and that much valuable information would be the result.

Manchester Geological Society.—*January* 27*th*.—Two beautiful specimens of Aviculopecten were presented by Mr. Butterworth, of Moor Side. They were remarkable for retaining their natural convex form; specimens of this fossil being generally found quite flat. They are from the large nodules lying over the Upper Foot Coal at Doghill, near Oldham; the first mine above the Gannister.

A conversation then took place respecting the marine shells found in the black shales on the banks of the river Tame, at Dukinfield. Mr. Taylor said he had there found a *Goniatites Listeri* as large as the palm of his hand, and also a crinoidal stem. Mr. Binney had found Orthoceratites at the same place. These beds were generally looked upon as some of the lower series of coal-measures brought up by a fault; but no one has examined thoroughly the strata, and no fault having been proved, they may not unfairly be presumed to belong to the upper coal-field. Mr. G. Charlton said there was a sufficient breadth of strata between those known on each side to admit of the existence of a fault, but there were no indications of one that could throw up the lower measures there.

The papers read were—

1. "On the Cambrian Strata of the Isle of Man," by John Taylor, Esq., being the results of observations made on the Manx Cambrians during a series of visits, but more especially in the autumn of last year.

The sum of Manx geology may be stated in a few words. Along the southern coast, on each side of Castletown, and having that place as a centre, the Carboniferous limestone skirts the coast. It is separated into two divisions by a thick bed of dark and thinly-laminated shales, many of which are covered with Producti, etc. From underneath the lower beds of limestone, what Mr. Cumming calls the conglomerate of the Old Red Sandstone, crops out. This bed, however, the author takes to be a sort of passage from the Carboniferous downwards, rather than a representative of the Devonian formation. Certainly the Palæontological evidence is not in favour of its being decidedly Old Red, for the fossils most abundant are *Orthis Sharpii* and *Favosites polymorpha ;* both these extinct forms being common to the Upper Silurian as well as the Devonian, and the latter is common both to them and the Carboniferous limestone. Striking off from the coast inland, we find that these two deposits terminate at about two miles ; and in going up the Silverburn we see them cropping out, first the limestone and afterwards the red sandstone, both abutting against the highly-inclined strata of the Cambrian beds. The area which the limestone and red sandstone occupy is of a crescent form, having Poovlash on its right horn and Santon-burn on its left: the whole distance being much disturbed by outbursts of greenstone and trappean dykes.

From Port le Maury, along the north-western coast, we come upon the slate rocks, until we arrive at Peel, where a dun-coloured red sandstone rests upon them ; the red sandstone rocks lying at a low angle. These beds skirt the coast as far as the Point of Ayr, but do not extend into the interior for a greater distance than four miles ; the farthest inland point to which they extend being Kirkpatrick, where they are seen resting on the still highly-inclined Cambrian strata. With the exception of these Palæozoic deposits, and the more recently accumulated beds of Pleistocene age, the whole of the island is occupied by the Cambrian formation.

The author, referring to an editorial note attached to an article of his published in the 'Geologist' magazine of September last, in which Mr. Salter observes that we cannot tell whether these Manx clay-slates belong to the Cambrian formation or not, until they have been properly surveyed, says,—"At the most, this *dictum* is not attaching much value to the researches of Strickland, Forbes, or Cumming ; and any one acquainted with but the slightest knowledge of the Welsh Cambrians, on arriving at the island would not fail to recognize in its highly-contorted beds the representative of the former. I have no doubt whatever but that these Manx beds belong to the true Cambrian system. So nearly are they allied in mineral structure to those of Wales, that practical slate-dealers are unable to tell the difference between the slates obtained from the recently opened quarries of the island, and those obtained at Conway. And not only in the mineralogical appearance of the beds is there a similarity, but also in the organic remains, few though they be, which the Manx beds have yielded. At the same time we have seen that the supposed representative of the Old Red Sandstone, as well as the overlying Carboniferous limestone, both abut and rest on the clay-slates themselves."

Owing to the contortions into which the clay-slates are thrown, it is exceedingly difficult to ascertain their thickness. It cannot be less, however, the author thinks, than several thousand feet. The general strike of the beds is E.N.E., the strata running in parallel mountain-ridges, of which the principal one is that passing through Slieanwhallin and North Barrule. The valleys between these principal ridges are mostly formed by the synclinal depressions of the strata—from one end to the other—the whole tract of the Cambrians being highly contorted, and broken up by faults. So powerfully have these contorting forces operated, that the author has seen, within the distance of twenty yards, no fewer than a dozen foldings. A good section, showing this phenomenon, may be seen along the vertical coast-line around Douglas Head, for a distance of three miles. Again, on the opposite side of Douglas Bay, the same feature presents itself; and a little further in the easterly direction, at Onchan, the rocks bounding its little bay are seen to form a huge anticlinal ridge, the strata passing over like the roof of an arch. All along this coast, as far as Ramsey, the same phenomenon may be studied. At times, however, great faults have intervened, arresting the agency which has so folded the strata, and turning it into another direction. Thus, on the eastern side of Greeba Mountain, the strata are exceedingly disturbed, great veins of white quartz intersecting the beds. On walking along the ridge of the mountain, and along the strike of the rocks, we perceive this folding suddenly to cease, and then the beds lie at a steep angle, but quite free from contortion. This peculiarity has been taken advantage of by Messrs. Ashe, and splendid slabs, fit for street pavements, etc., are now obtained from a quarry which they have recently opened there. Again, on a mountain opposite to Greeba, and to the east of it, at the Craig, we find the beds dipping at an angle of about 45°; but these are finely-laminated blue slates, quite sonorous and hard, and fit for building-purposes. The masses are also naturally cloven into rhombic forms. Further towards Peel, there is a slate quarry recently opened by the Isle of Man Slate Company, where the strata lie at a lower angle still, for the dip here is only about 30°; the rhombic cleavage still prevailing. But by far the finest section is that at Dalby, and seen from the coast. A fault occurs here, and, on the one hand the beds are in nearly a vertical position, whilst on the others are seen abutting against them.

The colour of these beds is not persistent. Near Douglas they have a sort of olive-grey; at Santon-burn they are of a claret colour; and in the slate-quarries alluded to they are perfectly blue. Like many of the Welsh slates, the surfaces of the laminæ are often coated with pyrites; and between the chinks of the cleavage the faces of the masses are nearly always so coated. The degree of hardness is also variable: in some places they are almost as soft as common coal-shales, whilst in others sufficiently hard and crystalline to take a considerable polish.

The organic remains are very scarce, and until a few years ago were thought to be quite absent. A friend of mine, Mr. Grindley, has, however, discovered a *fucoid;* and in the quarries behind Castle Mona Hotel the author has discovered both *fucoids* and the *tracks or castings of worms;* and in the slate-quarry of Messrs. Ashe, at Mount Craig, what he believes to be the section of an Orthoceratite. Near Laxey, ripple-marked slabs are exceedingly abundant.

At Dalby, and very near the spot where the above-mentioned fault occurs, a quarry has been recently opened in the vertical strata, where ripple-marks are, mostly plainly, to be seen. But by far the most important discovery Mr. Taylor considers is that made by him there last summer, that one of the vertical faces of the rock was distinctly marked by impressions, each about nine inches long, and following each other at a distance of about two feet. He says, "The impressions were about four inches on each side of a straight line, and were alternately on this side and on that. Three such impressions were distinctly visible, and doubtless on the same face of the slab more would have been met with, but masses of over-lying rock intercepted the view. These impressions were described by me in the above-mentioned article in the 'Geologist.' In opposition to Mr. Salter, who had not then seen the slabs, but only the drawing, and who was of the opinion that they were not organic, Mr. Mackie stated that he had no doubt of their organic origin, but was of the opinion that they belonged to a gigantic species of Lingula.* Whatever they are, I cannot tell, I have simply brought them before the notice of science, conscious that all traces of fossils which are found in the Cambrian beds will receive a careful examination. Whether they be *actual* footprints of some Chelonian, or merely imprints, I cannot say; but impressions of Chelonians have been found in the lowest Silurians of North America, and more recently, I believe, in Scotland. The outline of these Dalby impressions very much resembles the dotted outline of the Protichnites, figured in Owen's 'Palæontology.'"

Thin veins of Anthracite have been met with at Laxey; and near to Ballacraine, a lode of impure graphite, or plumbago, crosses the valley.

Granite comes up to the surface in two distinct places on the island, and in both instances emerges from beneath the slate rocks. The first place is at South Barool, and the second at Dhoon, about two miles beyond Laxey. In both instances it comes up as a huge bulging mass, or boss; in the former place occupying many square acres in extent. Around this boss there is a belt of pure white quartz, some score or two of yards wide, and containing large flakes of mica interspersed among it. At the junction of the clay-slate with the quartz the mica is more abundant, and for a short distance a sort of mica-schist passes into the slate-rocks. In the Cambrian strata of the island several layers of rock are fine-grained sandstone, as at the eastern horn of Douglas Bay, and again at the "Quarter Bridge," about two miles from Douglas. It is in the neighbourhoods of the granite that the metallic veins and lodes are richest, for at one place the Foxdale mines are most profitably worked, and near to the other we have the extensive works of the Laxey Mining Company.

The Cambrian strata in the island bear evidence of extensive denudation, for most of the valleys have been formed by the literal scooping out of rock; and it is not unfrequently the case that the hills on each side of such valleys may be seen to be the abutments of great arches of strata which have once bridged over.

There is just a glimpse of what this old land may have been composed of preserved in the Red Sandstone conglomerate. At Peel, where this conglomerate may be traced resting upon the inclined edges of slates, the imbedded pebbles are many of them of quartz, but *none of slate;* whilst these are accompanied with *limestone pebbles*, in which may be seen fossils of an undoubtedly Silurian character. Some of these limestone pebbles are several inches in length; consequently, they could not have been carried from a great distance, and the solid rocks whence they were derived must have been in the neighbourhood of the conglomerate itself, at the time when it existed as a rough shingle beach. It is therefore probable that the parent rocks of these fossiliferous pebbles once overlaid the present Cambrian strata.

2. "On the Edmond's Main Colliery Explosion." By Thomas Farrimond, Esq.

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* This is scarcely correct. I noticed the peculiar fibrous structure which appears in the interstices between the cast and the matrix, and suggested, or meant to do no more than suggest, that this was possibly fibrous shell-structure, like that of the Lingula, or Pinna. I should scarcely like to say I believed in the former existence of a Lingula six or eight inches long. I exhibited the specimens kindly sent to me by Mr. Taylor at the meeting of the Geological Society, February, 1863. Unfortunately, I was not able to be present; but I could not learn from other Fellows who were there that any decided opinion was expressed about them.—Ed. Geol.

Royal Society of Edinburgh.—At a conversazione held by the Royal Society of Edinburgh, on the 25th February last, specimens, maps, photographic views, and sketches, illustrative of the geology[*] and mineralogy of Otago, New Zealand, were exhibited by Dr. Lauder Lindsay. They consisted of—

I. A series of auriferous rocks and deposits, displaying—1. Their general resemblance to those of all other auriferous countries yet known. 2. "Bed-rock," or metamorphic slates probably of Silurian age; these slates probably form the geological basis of the greater part of Otago, especially of central mountain-ranges, which vary in height from 5000 to 9000 feet. 3. The general resemblance of these auriferous slates to the metamorphic slates of Lower Silurian age of the Scottish Grampians; from this Dr. Lindsay suggests the probable diffusion of gold in Silurian slates, and in their derived "drifts" or alluvium in Scotland, "nuggets" having been already found, according to his statement, in Leadhills, Tweeddale, Breadalbane, Sutherlandshire, etc. 4. "Drift," of Cainozoic age: named—Upper, consisting of clays, boulder-clays, and "chopped-slate" gravels; Lower, characterized by lignite beds and associated strata. The gold-mining in Otago is mostly alluvial digging; in the Auckland [Coromandel] gold-field it is mainly quartz reefing.[†] The chief auriferous district is the basin drained by the great central Lakes Hawea, Wanaka, and Wakatip, and the Clutha River, with the feeders or tributaries. The principal works are in the Tuapeka and Dunstan gold-fields, and at the Lindis and Arrow diggings. Auriferous drifts occur also on tributaries, mostly head-waters, of the Mataura [Nokomai gold-field], Tokomairiro [Woolshed], Waipori [Waipori], Shag and Taeri [Mount Highlay diggings], Waikouaiti, and other rivers and streams in different parts of province, as well as on the coast [Moeraki beach], and in and around the capital, Dunedin [Saddle-hill]. Speaking generally, the greater part of Otago is auriferous, namely, over an area nearly equal to that of Scotland. 5. Minerals associated with gold, or occurring in the auriferous drift—iserine, prevalent and abundant, cinnabar, cassiterite, aquamarine [beryl], avanturine, etc. The prediction as to auriferous character of certain New Zealand rocks was made by Rev. W. B. Clarke, of Sydney, Government geologist of New South Wales, in 1851. Since then, in chronological order, we have Aorere, Collingwood, Wangapeka, Buller River, and other diggings; operations begun 1854–7: Coromandel diggings; operations begun 1852: the discovery of Tuapeka, by Thomas Gabriel Read, 4th June; proclaimed a gold-field, July; and first gold-escort, 12th July, 1861: the Dunstan and Nokomai, proclaimed gold fields 23rd September, 1862: the New Zealand Gold-fields Act, 1858–60–62: the Otago Gold-fields Regulations, 7th October, 1861; amended 27th June, and 21st July, 1862. In respect to the auriferous productiveness of Otago during eighteen months, from the discovery of Tuapeka to the close of 1862, the total yield of gold was 550,000 oz., of the value of upwards of two millions sterling; probably in the following proportions:—from the Tuapeka gold-field, 360,000 oz.; Waitahuna, 90,000 oz.; Dunstan gold-field, 80,000 oz.; Waipori, 7,000 oz.; Woolshed, 6,000 oz.; Nokomai gold-field, Highlay, Lindis, Noeraki, etc., 7,000: total, 550,000 oz. Towards the close of 1862, the mining population of Otago was 7,500, and a fortnightly escort brought to Dunedin upwards of 30,000 oz. of gold, giving to each digger an average of at least 1 oz. per week. Up to 31st March, 1862, the total export of gold from New Zealand was:—from Otago, 359,639 oz. = £1,393,600; Nelson, 46,591 oz. = £180,541; Auckland, 354 oz. = £1,372: total, 406,584 oz. = £1,575,513 value. With regard to gold-mining, Dr. Lindsay considers it destined to become one of the regular, permanent industrial resources of Otago; and he looks upon the supply of gold as at present unlimited, and considers all mechanico-chemical contrivances at present known as inadequate to the exhaustion of its auriferous deposits.

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[*] *Vide* chapter on "Geology of Otago," in a lecture on 'The Place and Power of Natural History in Colonization, with special reference to Otago.' Pamphlet, pp. 30. Dunedin, January, 1862.

[†] *Vide* papers on "Geology of the Otago Gold-fields," and on "Geology of the Auckland Gold-fields," read before Geological Section of British Association at Cambridge, October 5, 1862.

II. A series of lignites or brown coals. These were divided into, first, those of Cainozoic age, contained in the lower or older auriferous drift, and probably co-extensive therewith, and showing the abundance of the deposits, and their general distribution over the province. Other specimens displayed the transition stages from wood to coal, and illustrated the general resemblance, on the one hand, to the "Surturbrand" of Iceland, and the brown coal of Germany [Bonn, etc.]—Cainozoic lignites; and, on the other, to the "coals" of Mesozoic and Palæozoic ages. There were also some selected for comparison with the older and newer Cainozoic lignites of the Province of Auckland [Drury, Hunua, St. George's Bay, Auckland, etc.], and with the Palæozoic [Carboniferous] and Mesozoic [Cretaceous and Jurassic] coals of the province of Nelson. The second series of specimens were the so-called "coals" of Fairfield, Saddlehill, Tokomairiro, Clutha, etc.; sold at a market-price in Dunedin of £2 per ton. Appended to the specimens were the results of chemical analyses. Of the associated strata, the specimens exhibited were—quartz-conglomerate ["cement"] and sandstones, building-stones, clays, fire- and potter's clays, kaolins, ochres, laterite, shales and limestones, partly fossiliferous [Dicotyledonous leaves, etc.]; and of included minerals—iron-pyrites, alum, etc.

III. A series of fossiliferous limestones and associated strata, instituting a comparison with similar strata in other parts of New Zealand, at present supposed to be—1. Cainozoic, representatives of Eocene [Bognor beds, etc.], beds, etc.; Mesozoic, Cretaceous and Greensand, representatives of Maestricht and Faxö beds, etc.; Jurassic, containing *Plesiosaurus australis*, etc.; Triassic [equivalents of the Muschelkalk.]—3. Palæozoic, Permian and Carboniferous.

IV. Moa-bone deposits, organic remains mostly of dinornis, partly of palapteryx, etc.; age partly recent, partly Cainozoic, from the Waikouaiti bed, etc.

V. Kauri-gum deposits, indicative of former prevalence of Kauri forests over great part of Otago, mostly in Cainozoic strata [auriferous drift, etc.], Waitahuna, Tokomairiro, basin of the Clutha, etc.

VI. Volcanic [Trappean] rocks, mostly Cainozoic, with a general resemblance of those of Dunedin to those of Edinburgh. Basalts, columnar, spheroidal, granular, schistose [clinkstone and Lydian stone]. Contained minerals, zeolites, olivine, augite, etc. Tuffs, amygdaloidal, slaggy or scoriaceous; comparison of latter form with the scoria of the extinct craters of Auckland. Contents: Sulphur and sulphur muds, steatites, lithomarges, ochres, and umbers (used as pigments); siliceous and other pseudomorphs; schorl, nephaline, and other minerals; porphyries and amygdaloids [basalt and claystone, etc.], trachytes, etc.

VII. Illustrations of the parallelism between the Kjökkenmöddings of Denmark, and the refuse-heaps of former Maori pahs and villages. Shell-mounds, edible and existing species of *Cardium*, *Ostrea*, *Mytilus*, *Patella*, *Venus*, *Haliotis*, etc., Maori ovens and baking-stones, ashes and charred wood, Maori stone hatchets, or "celts" of clinkstone, Lydian stone, or nephrite, eggs and bones of moa mostly long bones, bones of man, native dog, seal, fish, and various birds—mostly existing species penguin, albatross, rail, apteryx, etc.; bones partly charred, calcined, gnawed, broken, or marked by stone hatchets.

VIII. Insufficient data for accurate chronological grouping of rocks of Otago, arising, first, from a great portion of province remaining to be explored, and the very limited portion of settled districts yet geologically examined, and those only superficially; and secondly, from the difficulty of determining European equivalents, and thereby age, in the present unsatisfactory state of geological classification and nomenclature.

IX. Provisional chronology of chief rocks of Otago, as known to the close of 1861. 1. Recent, superficial alluvium, brick-clays, certain moa-bone deposits. 2. Cainozoic, auriferous drift, upper and lower; lignite beds and associated strata, certain volcanic (Trappean) rocks, fossiliferous limestones, and clays, septaria beds of Moeraki, moa-bone and kauri-gum deposits. 3. Mesozoic, certain fossiliferous limestones. 4. Palæozoic, metamorphic slates, quartziferous and auriferous, possibly certain fossiliferous limestones, etc. The preponderance of strata were of the Palæozoic and Cainozoic age, especially of the auriferous slates and their "drifts."

MANCHESTER PHILOSOPHICAL SOCIETY.—*March* 11.—Mr. Crookes, F.C.S., exhibited a specimen, weighing 450 grains, of the new metal, thallium, which he discovered by spectrum analysis. He stated that he had found this element in comparatively large quantities in the deposit from the flues of Mr. Spence's pyrites burners. E. W. Binney, F.R.S., the President, said that of late years considerable attention had been devoted to the examination of the beds of sand and gravel found in the valleys formed since the deposition of the till or boulder clay. Sir Charles Lyell, in his valuable work 'On the Geological Evidences of the Antiquity of Man,' has given us many facts connected with these valley gravels, especially relating to the terraces of the higher and lower level gravels found in the valley of the Somme, in which the flint implements have been met with. As these two deposits are seen in the neighbourhood of Manchester, he wished to direct attention to all excavations that were being made in them, in order that any remains or implements which might be met with should be preserved. Doubtless, many interesting specimens have perished, owing to the parties finding them being ignorant of their value. Many years since, a former member of this society, the late Mr. F. Looney, F.G.S., in speaking of the superficial gravel found in this neighbourhood, at p. 23,* says: "Imbedded in the gravel near the river-courses are occasionally found the stone celts of the ancients, from which it is presumed that the rivers, since the country was inhabited, have either sawn their beds deeper or much exceeded their present volume of water. Several large trees have been dug up from the sand and gravel; part of one is now lying near the residence of the Rev. J. Clowes, at Kersal Moor, which was dug from the Show Field on his estate, at upwards of 23 feet elevation above the present level of the river. A case more illustrative of this was beautifully shown in the winter of 1820, during the cutting away of part of the high ground at Castlefield, near the tunnel mouth, for 16 feet below the level of the grass a wooden box was found. It was square and formed of four upright posts, driven into a bed of clay; the sides and bottom were closed in with logs of wood: the logs were rudely hewn, had been riven, not sawn, from

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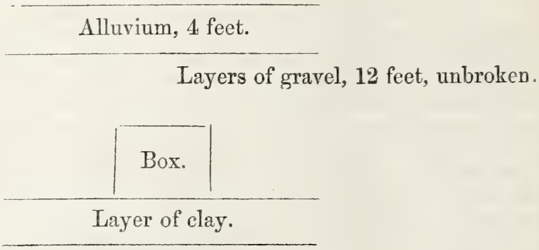
* 'List of Organic Remains,' etc., and where found, to accompany Mr. Elias Hall's Introduction and Map, by Mr. Francis Looney, member of the Literary and Philosophical Society of Manchester, published in 1836.

5 to 6 inches square; some greenstone boulders lay at the bottom, and the whole was covered with 16 feet of sand and gravel; 12 feet of the lower part had never been disturbed, the continuity of the layers being unbroken.

SECTION.



Alluvium, 4 feet.

Layers of gravel, 12 feet, unbroken.

Box.

Layer of clay.

Gravel."

Mr. Looney was well known to be a most accurate and intelligent observer, and his mention of stone celts having been found at levels above the present river-courses appears to afford us fair hopes of their being found in the lower-level gravel if carefully looked for. But the most interesting fact is the finding of the wooden fabric, by the author termed a box, which, although smaller in size, bears some resemblance to the *crannoges* found sometimes in Ireland under the peat bogs. He (the President) had lately been to examine the place where it was found, which is to the south of, and just outside of the old Roman station of Mancunium, in company with a party who saw the fabric when it was first exposed, and stood in it afterwards. The locality of course is now much changed, but the person was able to point out to him the position where it was found, which is now covered by No. 6 arch of the Altrincham railway, and said that it was about 6 feet square and 4 feet high. The four upright posts driven into the clay were about 5 inches thick and roughly riven, as were also the slabs forming the sides and bottom. His informant did not notice any top to the fabric, or how the slabs had been fastened to the posts, but he remembers a layer of cobble stones, each about 6 inches in diameter, forming a kind of pavement, being in the bottom of it. Upon these stones were some bones, which he examined, but did not recognize any of them as human. All the wood appeared to be oak, but it was very rotten, and fell to pieces soon after it was exposed to the air. None of it was preserved. Under the clay, the red rock (Trias) was found at a short distance. The geological position where the fabric was found is in the lower-level gravel, about 29 feet above the water of the present river Irwell. For whatever purpose it was made, there can be little doubt as to its having been the work of man, and as we are assured that the overlying sand and gravel was quite undisturbed, there can be as little question of its great antiquity, reaching as far back as the age of the lower-level gravels of the valley of the Somme, in France, where the flint implements have been found. Doubts have been raised as to these flints having been fashioned by human hands, but as to the origin of the wooden fabric, if, as stated, it was covered by 12 feet of undisturbed sand and gravel, no such doubts can rationally be raised.

The following paper, "On the Chemical Constitution of American Rock Oil," by Mr. Schorlemmer, Assistant in the Laboratory of Owens College, was communicated by Professor Roscoe:—

In a paper published in the October number of the Chemical Society's Journal, the author showed that the products of the distillation of cannel coal at a low temperature contain a series of homologous hydrocarbons of the formula $C_n H_{n+2}$; and further that these are the hydrides of the alcohol radicles, as, upon treatment with chlorine, they yielded, by substitution of one atom of hydrogen by one of chlorine, the corresponding chlorides, from which other derivatives may be obtained.

In the portion of the oil boiling below 120° C., the author found the following four hydrides:—

$C_{10} H_{12}$	hydride of amyl, boiling-point	39° C.
$C_{12} H_{14}$	hydride of hexyl, ,,	68° C.
$C_{14} H_{16}$	hydride of heptyl, ,,	98° C.
$C_{16} H_{18}$	hydride of octyl, ,,	119° C.

Of these, the hydride of heptyl or œnanthyl is the most interesting, as it was previously unknown, and he therefore undertook the investigation of its derivatives, concerning which likewise our knowledge is very limited and contradictory. Thus, for instance, many chemists state that the alcohol obtained by the distillation of castor oil with potash is heptylic alcohol, whilst others regard it as octylic alcohol, and it is only by the most recent experiments of Bouis* that we learn with certainty that this substance is octylic alcohol, inasmuch as he obtained the true heptylic alcohol by the action of nascent hydrogen on œnanthol. For the purpose of this investigation the author endeavoured to obtain the hydride of heptyl from the American petroleum, as the yield of this substance from the cannel oils is but small, and the labour of purification tedious and disagreeable.

The existence of this hydride in the petroleum was rendered probable by the fact of the discovery of hydride of hexyl by Pelouze and Cahours.†

The oils which he examined are those known by the name of turpentine substitute, and obtained as the first products in the rectification of the crude oil. Different samples of the commercial articles possess very different properties; the specific gravity lies between 0·70 and 0·75. One sample began to boil at 30° C., and the greatest portion distilled over below 100° C., whilst others between 80° and 150° C., and others between 100° and 200° C.

When the oils are subjected to fractional distillation, no product of constant boiling-point is obtained, the oils requiring for this purpose a preliminary purification with concentrated nitric acid.

The greatest portion of the oils remains unattacked, and the acid solution contains nitrobenzol (from which aniline was prepared), nitrotoluol and binitrotoluol, and small quantities of fatty acids produced from traces of olefines which are probably contained in the crude oils.

The author tried to separate these olefines by adding bromine to the crude oil until the colour of the latter no longer disappeared; a few drops, however, are sufficient for a large quantity of the oil, and when the whole is subjected to distillation, a very few drops of bromine compounds of a high boiling-point remained behind, the quantity of which was too small for further examination.

The oil after this treatment was well washed, dried over potash, and rectified repeatedly over sodium. By fractional distillation, the following four hydrides were obtained, and found to be identical with the hydrides from the cannel tar:—

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* Compt. Rend., 55, 140.

† Ib. 54, 1241.

$C_{10} H_{12}$	hydride of amyl,	boiling-point	34° C.
$C_{12} H_{14}$	hydride of hexyl,	,,	68° C.
$C_{14} H_{16}$	hydride of heptyl,	,,	98° C.
$C_{16} H_{18}$	hydride of octyl,	,,	119° C.

In addition to these he obtained a small quantity (about one gramme) of a liquid boiling between 20° and 30° C., and hence we may infer that also hydride of butyl is present in small quantities.

The author stated in the paper above alluded to that hydride of amyl boils at 39° C. The same compound from petroleum boils at 34° C. He finds, however, that the presence of traces of foreign substances alter the boiling-point of this body very considerably. Thus, for instance, he obtained from the crude oil about one ounce of a liquid which boiled from 15° to 20° C.; after treatment with nitric acid, the volume of the liquid remained almost unchanged, showing that only a very small quantity of substance had been removed; but, after drying with potash and rectifying over sodium, it was found that a mere trace of the liquid boiled below 30° C; nearly the whole distilled at 34° C., and consisted of hydride of amyl. Of the four hydrides which he isolated, he had only prepared the hydride of heptyl in quantity; four gallons of turpentine substitute boiling between 80° and 150° C., yielded three pounds of the pure compound.

In order to obtain from this other heptyl compounds, it was transformed into the chloride according to the excellent method described by Hugo Müller,* which consists in the addition of a small quantity of iodine to the substance which is to be treated with chlorine. The substitution occurs much more rapidly in this case than when chlorine alone is employed, and goes on in absence of the daylight, so that a rapid current of chlorine gas can be led into the liquid without any chlorine escaping with the hydrochloric acid vapours.

Hence it is seen that the constitution of American petroleum, at least that portion boiling below 120° C., is quite analogous to that of the oil from cannel tar.

Petroleum consists mainly of the hydrides of the alcohol radicles, it contains very small quantities of benzol and toluol, and probably traces of olefines, whilst in the cannel coal oil the hydrides are found in smaller quantities, and benzol and toluol in proportionally larger amounts. In the oil obtained by distillation of boghead coal, Greville Williams has discovered a series of hydrocarbons possessing the composition and physical characters of the hydrides $C_n H_{n+2}$, also benzol and its homologues and olefines.†

The rock oils obtained in other countries appear to posses a somewhat similar constitution.

Thus, for instance, Warren de la Rue and Hugo Müller‡ found in the Rangoon tar, benzol, toluol, xylol, and cumol and hydrocarbons of the formula $C_n H_{n+2}$. They were, however, unable to isolate from these a compound of definite composition and boiling-point. The rock oil from Sehnde, in Hanover, consists, according to the investigation of Busenius, Eisenstuck,§ and Uellsmann,|| of hydrocarbons of the same general formula, but they likewise failed to obtain definite products.

Pebal and Freund** found in the rock oil from Gallicia benzol and homologues, carbolic acid and homologues, and hydrocarbons which are not attacked by the strongest acids, and probably identical with those previously mentioned.

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* Journ, Chem. Soc., 15, 41.

† Phil. Trans. 1857.

‡ Jahresbericht, 9, 606.

§ Liebig's Annalen, 113–115.

|| Ib. 114–279.

** Ib. 115, 119.

In the Microscopical Section, (16th February,) Mr. R. D. Darbishire presented specimens of mud and fossil shells (received through Dr. P. P. Carpenter) from the Post-pliocene or latest Tertiary deposits at Logan's Farm, Mile-end Quarries, near Montreal, Canada, described by Sir C. Lyell ('First Travels in North America,' vol. ii. p. 135), and in Papers by Dr. J. W. Dawson in the 'Canadian Naturalist,' 1858 and in 1859. Mr. Darbishire, in a note to the Secretary, stated that one of the peculiarities of the deposit is that it seems to have been formed in a quiet hollow. Spiculæ of sponges are found in position, as if the sponge had grown and been quietly buried on the spot. Amongst other characteristic fossils are numerous Foraminifera, and a siliceous and close-textured sponge, referred to Tethea, of the species *Logani*, which is now found in water from the tide-line to 200 fathoms deep.

COTSWOLD CLUB.—From a reprinted paper on *Gryphæa incurva*, with plates by Mr. John Jones, of Gloucester, which we have received, it appears that old and valuable club, the Cotswold, are devoting their resources to really good work. In Vol. III. of this periodical we printed a paper on *Rhynchonella acuta* by Mr. Jones, and the steps which that author then took to work out the identity of many so-called but unreal species he has repeated in respect to that more common and characteristic bivalve mollusk of the Lias, abundant and familiar, though it would seem in all its varieties yet not always a well-known shell,—the *Gryphæa incurva* of British and *Gryphæa arquata* of foreign writers. The following extracts from Mr. Jones's paper will convey the views he promulgates in respect to the various forms of Gryphæa which have received specific names.

"*Gryphea.*—'A free, (except when very young,) unequal-valved, inequilateral bivalve, larger valve involutely curved, concave, smaller valve flattish, beakless; hinge, a transversely striated pit, containing an internal ligament, without teeth or crenatures.'

"The Liassic species, recognized by most English writers, to which the foregoing generic terms apply, are those to which we have now to address ourselves, and may be stated as follows:—*Gryphæa incurva*, Sowerby; *G. suilla*, Schlotheim; *G. obliquata*, Sowerby; *G. Maccullochii*, Sowerby; *G. depressa*, Phillips; *G. cymbium*, Lamarck; all of which, labelled as above, are to be found in most collections of importance throughout the kingdom, and are more or less common (as we believe) in this district.

"Upon inquiring where, as tyros, we may find pictorial illustrations of the differences between them, we learn that we must refer to the works cited as follows:—For *G. cymbium*, to the 'Encyclopédie Méthodique;' the 'Petrefacta Germaniæ' of Goldfuss; the 'Coquilles Fossiles des Environs de Paris' of Deshayes; Sowerby's 'Mineral Conchology;' or Phillips's 'Geology of Yorkshire.' For *G. depressa*, to the last-named work. For *G. incurva*, to two of the former works; to the 'Petrefacten' of Zieten; and Parkinson's 'Organic Remains.' For *G. suilla*, to Goldfuss, 'Petrefacta Germaniæ.' For *G. obliquata* and *G. Maccullochii*, to Sowerby's 'Mineral Conchology.'

"It is scarcely necessary to observe, that all these works are of so expensive a character, as to place them beyond the reach of the great majority of geological students; that they are all out of print, and not always attainable by those who *can* afford to purchase them; hence, therefore, the desirability of carrying out the design we have formed. It will be seen in the sequel, that we shall have occasion to refer to various other supposed species, described by Continental authorities.

"The first which claims our notice in stratigraphically ascending order is the *Gryphæa incurva* of Sowerby, or *arcuata* of foreign writers, the latter being the name under which it was described by Lamarck, the typical form of which has been figured by the following, amongst many other authors:—Bourget, 1742, Traité des Pétrifactions (Paris), pl. 15, f. 92; Walcot, 1779, Description of Petrefactions near Bath, p. 51, f. 34; Encyclopédie, 1789, p. 189; *G. arcuata*, Lamarck, 1801, Système des Animaux sans Vertèbres, p. 398; *G. arcuata*, Parkinson, 1811, Organic Remains, vol. iii. p. 209, pl. 59, f. 4; *G. incurva*, Sowerby, 1815, Mineral Conchology, vol. ii. p. 23, pl. 112, f. 1, 2; *G. arcuata*, Lamarck, 1819, Animaux sans Vertèbres, vol. vi. p. 198, no. 4; *G. incurva*, Defrance, 1829, Dictionnaire des Sciences Naturelles, xix. p. 536; *G. arcuata*, De Blainville, 1825, Manuel de Malacologie et de Conchyliologie, p. 59, f. 4; *G. incurva*, Zieten, 1830, Die Versteinerungen Würtemberges, p. 65, pl. 49, f. 1: *G. arcuata*, Deshayes, 1831, Descriptions des Coquilles Caractéristiques des Terrains, p. 98, pl. 12, f. 4, 6; *G. arcuata*, Goldfuss, 1835, Petrefacta Germaniæ, pl. 8, f. 1, 2; *G. arcuata*, Roemer, 1836, Die Versteinerungen des Nord-Deutschen Oolithengebirges (Hanover), p. 62; *G. arcuata*, Schmidt, 1846, Petrefacten-Buch, p. 61, pl. 18, f. 3; *Ostrea arcuata*, Deshayes, 1849, Traité Elémentaire de Conchyliologie, pl. 56, f. 8, 9; *Ostrea arcuata*, D'Orbigny, 1850, Prodrome de Paléontologie Stratigraphique, vol. i. p. 220. It is, in fact, the shell invariably figured as the best type of the subgenus to which it belongs, and cannot fail to be recognized from the rudest figure, or from the following description, which is here somewhat amplified from Sowerby.

"*Specific Character.*—'Elongated, very involuted, right side' presenting a more or less 'strongly marked, or an obscure lobe,' (when viewed with the smaller valve placed downwards, and the umbonal portion turned away from and at right angles to the front of the observer,) 'lesser valve oblong,' 'externally concave.'

"This description applies only to the ordinary adult form, than which none would appear at first sight to be more easily determinable; but the following list of what are considered by some authors of repute to be distinct species, and merely synonyms of one, by others, will at once give an idea of the notable modifications and changes of form of which this species is susceptible, the shells named in it representing every imaginable gradation between the outlines of the common oyster and those of the most perfectly developed *G. arcuata*. *G. Maccullochii* of Zieten, t. 49, f. 3; *G. læviuscula* of Zieten, t. 49, f. 4; *G. ovalis* of Zieten, t. 49, f. 1; *G. Maccullochii* of Sowerby, t. 547, f. 1, 2, 3; *G. gigantea* of Sowerby, t. 391; *G. obliquata*, Goldfuss, t. 85, f. 2; *G. obliquata* of Sowerby, t. 112, f. 3; *O. irregularis*, Goldfuss, t. 79, f. 5; *O. læviuscula*, Goldfuss, t. 79, f. 5; *O. ungula*, Münster, 'Handbuch,' (young,) t. 325; *O. semicircularis*, Roemer; *O. irregularis*, D'Orbigny, 1853, Prod. vi. p. 238; *O. intermedia*, Terquem; *G. depressa*, Phillips; *G. lobata*, Buvignier. Although oysters have been found in much older formations, as exemplified by the unique specimen of *Ostrea nobilis*, from the carboniferous limestone of Belgium, which may be seen in the British Museum, with others from the Triassic 'Saliferian' of St. Cassian, they amount in number of species, in the opinion of Mr. S. P. Woodward, to three only, and it is first in Jurassic strata that they make their appearance in any remarkable number or variety.

"Taking into consideration this fact, with that of the universally admitted variety of forms attributable to one species: to those who have interested themselves in the theory of transmutation, as originally propounded by Lamarck, subsequently by the author of the 'Vestiges,' and since, more practically by Darwin, in his treatise 'On the Origin of Species,' the elaboration of figures, and the minute details here presented, although apparently uselessly repeated, may yet assume an aspect of interest which they could not otherwise possess. *Ostrea interstriata* (*Plicatula* of Emmerich) of the White Lias, and the small oyster which covers the slabs of Lower Lias at Wainload, Westbury, Penarth, etc., associated with *Modiola minima*, recognized by Buckman and other local writers as *Ostrea liassica*, are the earliest known to us in this district. Distinctly gryphoid forms occur considerably higher in the series, and are most abundant from the zone of *Ammonites Bucklandi*, to that in which it is supposed to be replaced by *Gryphæa obliqua;* but any one who has carefully examined these in considerable numbers, and can therefore fully appreciate the infinite diversity of form which they assume, rendering the determination of the differences between Oysters and Gryphites exceedingly perplexing, may possibly, in the sequel, feel disposed to adopt the suggestion of Quenstedt, that *Ostrea liassica* may really be the ancestral precursor of the species under consideration."

Six plates of illustrative specimens are given by Mr. Jones, and six quarto pages of minute description and comparison.

The actual vertical range of this species extends, Mr. Jones believes, nearly to the base of the Lias formation, and much lower than the beds in which it first becomes known to us by the name, hitherto applied to its commonest form. "Upon close inspection, almost every specimen of Gryphæa will show that it has been in its earliest stage attached, by the flattened or scarcely rounded extremity of the beak, to a foreign body, and it is noticeable that the symmetrical development of the adult appears to have mainly depended upon the period at which it became free, the comparative duration of which, in various individuals, being indicated by the extent of area so rounded or flattened. . . . Upon transferring to paper the outlines of that portion of the shell only which could have existed at the time of its assuming its liberty, which is easily done by tracing, in well-cleaned examples, those lines of growth of which the edges converge at the point where the profile curve of the external portion of the true apex commences, and from which the lines of the ligamental fossa recede, it will be clearly seen that it must once have so closely resembled the young of an oyster, as to render it difficult to distinguish the one from the other." Having arrived at the conclusion that the young Gryphite must, for a period more or less uncertain, resemble an oyster, Mr. Jones's figures specimens to show how long such resemblance might endure, and to what extent it could proceed; one of these being attached by a base so large, the upper valve so rugose and convex, with ridges following, and corresponding with the inequalities of the shell upon which it grew, exhibiting very obscure and irregular concentric lines of growth, and an appearance so completely that of an oyster, and different to that of a Gryphite, "that no one," Mr. Jones says, "who had never seen similar specimens, in a series of still further advanced stages, could admit its relationship in any degree to the latter."

Could the young animal, by its own volition, free itself from connection with the body to which it had attached itself? This Mr. Jones thinks may be answered affirmatively, from the fact, that in the majority of instances, that connection could have endured but for a short time. The primary point of adhesion must in general have been so small in the young fry, and applied to surfaces so even, that a very slight exertion of force of any kind, either voluntary or involuntary, would have sufficed to detach it; but it can be readily conceived that in the event of adhesion taking place to uneven surfaces, the union between the two bodies must have become so complex as to render separation impossible, except by the application of very considerable force.

In the event of contact remaining unnaturally prolonged, as in the case of *Ostrea læviuscula* and *O. irregularis* of Münster, the foregoing observations would in all cases properly apply.

"There can be no doubt, that the great confusion of ideas which has existed with regard to what we consider to be one species, as evidenced by the hosts of synonyms for it, to which we have been compelled to refer, arose from that love of species-making which characterized most of our earlier palæontologists. No sooner did an abnormal form present itself, than it was seized upon and *named* as a new species, whilst the examination of the series would have shown its true connection with common types. In species of which the number varies so much individually, as in the oyster-tribe generally, this precaution is most essential, to enable us to arrive at safe conclusions in this respect: the most *symmetrical* forms having been set up as types, whilst, in point of fact, these are rather exceptional than otherwise.

"We can convince ourselves," Mr. Jones concludes, "in the instance of *G. incurva*, that this shell is capable of assuming every shape between that of a flat oyster and one of so different a development as to have suggested the propriety of conferring upon the individuals exhibiting it, a distinct *generic* name. It has been shown, how the entire character of the shell has been effected, by circumstances which enforced upon it a more or less permanent adhesion to the body to which it had primarily attached itself; that the lateral furrow, upon the presence or absence of which specific differences have been supposed to depend, is one of the most fallacious characters upon which they can be based. We can perceive that the differences between the assumed species *G. incurva, obliquata, Maccullochii,* and *cymbium*, are less than those existing between the young, half-grown, or adult states of either. We know that other creatures, inhabiting the same sea-zones, pass upwards from the point at which they first appear, through a greater, or at least as great, a stratigraphical range as either of these. Do we not then rightly pause before we draw sharp lines of demarcation, whilst neither the facts presented to us in the formation under consideration, nor our knowledge of physiological facts, as exemplified in the existing life of our own epoch, afford us any valid pretext for so doing?"

To show in the clearest possible manner the nature of these differences, Mr. Jones has constructed a diagram, representing *Gryphæa incurva* of the best known-type and fullest dimensions. By uncovering the drawing from its younger portion upwards, may be made to appear in succession, first, its oyster condition; secondly, that of *Gryphæa suilla;* thirdly, that of *G. obliqua*, young; fourthly, that of *G. obliqua*, adult; fifthly, *G. incurva*, half-grown; sixthly, ditto two-thirds grown; seventhly, adult; eighthly, in its most aged form. A comparison of any of the forms we have referred to, made by placing almost any two shells of different sizes in juxtaposition, so that the curves of their beaks shall be as nearly as possible parallel, will exhibit the same difference of degree between them, in quite as satisfactory a manner.

The names by which the numerous varieties have been hitherto known, and under which they are figured, Mr. Jones suggests, may admit of use, as those of *varieties* only of *G. incurva*, as which they ought to be generally recognized. The results of Mr. Jones's investigations then may be thus stated, that not only is there no clear distinction between these so-called species when studied in a fairly selected series; that no particular form is special to any stratigraphical portion of the Lias; but that in the Cotswold district, wherever Gryphites numerously occur, all the forms most widely diverging from the ordinary type of *G. incurva* are found, presenting differences from it, so infinitely modified as to make arbitrary separation between them of specific value, quite as unintelligible as absurd. These observations may be applied with equal propriety to other species and genera of shells equally common in the Liassic strata."

The ANNUAL MEETING of this club took place on March 4th, on which occasion there was a large muster of the members and their friends from different parts of the county. Captain Guise, president, read the annual address, in which he gave a detailed account of all the different meetings which had taken place during the past year, and pointed out the various novelties which the members had noted in their excursions to Weston-super-Mare, Cardiff, Penarth, etc. After the address, the meetings for 1863 were fixed, and Mr. Buckman's report on the tumulus opened by the club at Nymphsfield last summer, was read; one very fine human skull and portions of other skulls obtained from this ancient burial-place, were exhibited. At the dinner fifty-eight members were present. Dr. Wright read a report on the collection of organic remains made by Miss Holland, of Dumbleton Hall. The Lias beds in the neighbourhood of Dumbleton consist of Lower Lias, Middle Lias, and Upper Lias. The report contained an enumeration of all the species found in each of these divisions of that great formation; these detailed lists will appear in the Transactions of the Society. Dumbleton Hill has long been a capital locality for the fossils of the marlstone and for the fish-bed of the Upper Lias. Dr. Wright likewise exhibited a vertebral and other bones of a large reptile, which had lately been discovered at Stowell Park. This saurian is new to England, although the same or an allied form has been found in a formation of the same age, the Great Oolite of Normandy. The bones belong to the genus *Teleosaurus*. The next communication was by the Rev. T. W. Norwood, on a tumulus which had been recently exposed at Foxcote, near Whittington, in this county. This locality had been visited on February 25th, when several human bones, horses' bones, and flint-flakes were found. In another part of this tumulus a vessel containing a number of Roman coins of Valens, Valentinian, Tetricus, Faustina, Constantine II., Claudius II., was said to have been discovered, together with a fragment of rude pottery and a piece of rusty iron. The author believed the grave to have been a Roman burial-place of about the fourth or fifth century. The next paper was an account of the natural history of the Severn, by Mr. John Jones, of Gloucester. In it lists were given of the fishes, shells, diatoms, and plants living in the estuary of the river.

Mr. Notcutt read an outline of the proceedings of the Cheltenham Working Naturalists' Association, formed in 1861, for the purpose especially of uniting the naturalists of the town in the effort to work out a complete flora and fauna of the district. The area which the Association has thus undertaken to work out, embraces a definite district laid out on the Ordnance map, and averaging a radius of about six miles from Cheltenham as a centre;—649 species are found within these limits. Of these 112 are new to the district, being unrecorded in the Flora published eighteen years since by Mr. Buckman; while 67 of the plants recorded in that work have not been seen by the members; of these, it is believed that 17 are either extinct in the places assigned for them, or are misnomers, while the other 50 will probably be yet rediscovered. The mosses have been studied by Mr. Beach, and his lists contain 146 species. In the animal kingdom, Dr. Bird has contributed a list of 24 species of mammals. Mr. Wheeler reports 159 species of birds, and eight species of reptiles are noted by the Rev. T. A. Marshall. The same gentleman has contributed lists of 567 species of Coleoptera and 172 species of Hymenoptera. Mr. Beach has detected 71 species of Mollusca, and Drs. Abercrombie and Wilson, 87 species of Diatomaceæ. Collections of several of the tribes investigated have been commenced to serve as a permanent record. It was also urged that it would be exceedingly desirable that the same work should be done for the whole county which is being done for this district.

NOTES AND QUERIES.

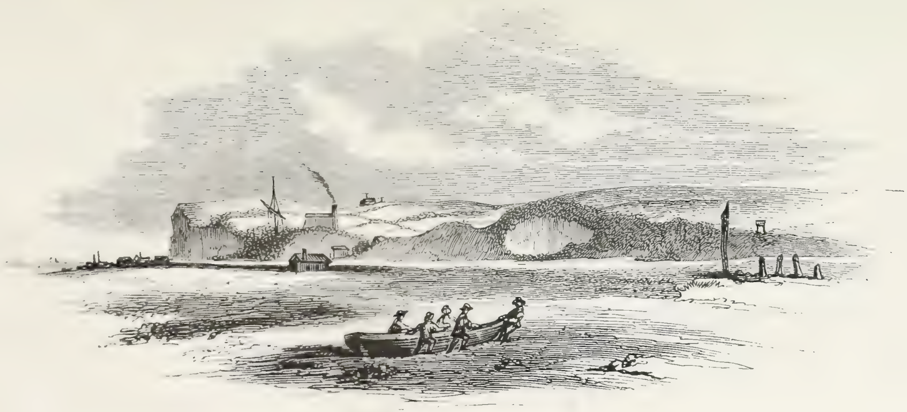
Highest Beds of the English Chalk.—For a long time the fossils from the Norwich chalk have been known to present slight, but peculiar distinctions from those of other districts; and the Norwich chalk has been often regarded as a higher stratum than any other in England. The recent description by M. Binkhorst (see "Reviews," vol. vi. p. 240) of the fossils from strata at Maestricht, containing casts of univalve-shells, such as occur in similar beds between Dover and St. Margaret's, showing their proximity to the highest cretaceous beds, has directed my attention afresh to a portion of one of the most interesting chalk sections in England,—that in the vicinity of Dover. Since William Phillips's admirable paper, read before the Geological Society in 1818, nothing has been published on the geology of that part of the Kentish coast; but, during a late visit, having obtained from the low cliffs at Kingsdown (left-side of view, Plate VIII.) specimens of *Micraster cor-anguinum*, unlike those usually found in the Dover and Maidstone Upper Chalk (see ordinary form, Fig. 6, Plate III.), but agreeing closely witht he gibbous variety so abundant in the Norwich chalk, I beg to solicit information from geologists of the characteristic features and fossils of the highest beds of chalk in any locality with which they may be acquainted. As the beds in the Kingsdown cliffs rise at a sharper angle than the general surface of the land, it is possible that the uppermost beds have more or less been sliced off by some denuding action towards Walmer Castle (to the right of the view, Plate VIII.).

Mr. S. P. Woodward informs me the chief characteristic shells of the highest beds of the Norwich chalk are—*Pecten concentricus, Ostrea larva, Terebratulina gracilis, Terebratella elegans, Rhynchonella octoplicata, Magas pumila*, and *Chama inæquirostrata*. The occurrence of these shells in any locality will be therefore indicative of the presence of strata representative of the Norwich beds. S. J. Mackie.

Didymodon Vauclusianum.—Since my memoir on this subject was published, the specimen has been thoroughly cleaned out by Mr. Davies, of the British Museum, and he has distinctly shown that the interpretation, that the last tooth in the jaw was the third molar, was erroneous. This tooth is therefore the second molar; the one immediately preceding it being the first; and the fractured tooth, instead of being the first molar, turns out to have been the last premolar. The specific and generic distinction of the Didymodon is, however, not invalidated by the detection of this error on my part, which, as in all similar cases, I hope to be the first to point out.

C. Carter Blake.

Mammalian Remains in Hampshire Gravel.—The remains referred to at page 110, have been kindly forwarded to us by Lieut.-Colonel Nicols.



UPPER CHALK CLIFFS ON THE SHORE BETWEEN WALMER CASTLE AND KINGSDOWN, KENT.

S. J. Mackie del.

The species are—*Elephas primigenius* (determined by Dr. Falconer) in the embedded lump of Tertiary rock, *Pectunculus Plumsteadiensis*, *Natica glicimeroides*, and *Rostellaria Sowerbii* (determined by Mr. Prestwich).—Ed. Geol.

Gallic Canoe.—The dredgings in the Seine have brought to light the interesting remains of a canoe fashioned of the trunk of a tree, 5½ mètres long, and 85 centimètres broad in the middle, and attributed by the French antiquarians to the Gallic era. In the same place seventeen pieces of Gallic money, a knife, a flint axe, and various pieces of pottery were found at the same time.

Lead Ore.—A vein of lead-ore has been discovered at Port Jervis, Orange County, N. Y., containing 80 per cent. of pure lead, and six feet wide by eight feet deep, in the Oneida Sandstone.

Mammalian Remains.—Dr. Buckland records, in the Geological Society's Transactions, vol. iv. p. 287, the discovery of "four large and entire tusks of elephants," in a garden opposite the chalk pit at the base of Loam-pit Hill, and on the north side of the turnpike-road. They were for some time (1817) in the possession of Mr. Lee, the owner of the extensive brick-works there.

Norfolk Broads,—Sir,—I should be much obliged if you could inform me of the origin of our "Norfolk Broads." They are, as the name implies, broad, comparatively shallow, sheets of water of various extent, generally a few miles only from the sea, and partially overgrown with reeds, etc. I have myself a suspicion that they are in some way connected with the Crag sea.—Yours truly, Charles Jicks, jun.

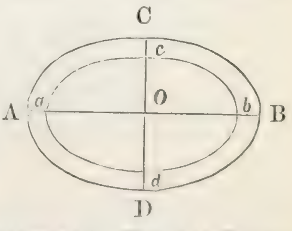
P.S.—It may be as well to add that the "Broads" above-named have, I believe, *always* some connection with a tidal river.

Woodlands, Thorpe, near Norwich, March 23.

Disturbance of the Sea.—The 'Grahamstown Journal' (February, 1863) makes the following statement:—"A farmer named Elliott, residing near Gusha River, while crossing the mouth of the Keiskama, a few days since, noticed an eruption in the sea, which was violently agitated and forced upwards as from the spouting of a whale. On approaching the spot as closely as possible, he perceived that a dense body of smoke rose as from a crater, and when the tide threw the surf over the spot it was immediately thrown some forty or fifty yards into the air, the water, for the circumference of half a mile, assuming the colour of the blackest ink. This continued for some fifteen minutes, and gradually died away with a rumbling sound."

Errata.—Sir,—The note "On a Progressive Change in the Form of the Earth," page 110 of the number for March, is, I am sorry to find, unintelligible, in consequence of the omission from the diagram of letters referred to in the text. The diagram ought to have been thus marked.—George Hamilton.

Queen's College, Liverpool, March 8th, 1863.



Errata.—Blackdown Greensand.—In Plate III. Sidmouth and Lyme Regis are interchanged as to positions.

Errata.—In Plate III. figs. 4 and 5 are transposed. Fig. 4 is Glyptolepis scale; fig. 5. Holoptychius scale.

Errata in Table of Bird Remains.—The × to *Coturnix* is put in the Maestricht instead of in the *Eocene* column, and the × to *Perdix* in the Eocene instead of in the *Miocene* column; the ? to *Gallus* and the ?

to *Gallus Bravardi*, also, are put in the Eocene instead of the *Miocene* columns. *Lathornis ? emuinus* is also accidentally put in the Maestricht instead of in the *Eocene* column. Insert the × in *Pliocene* column against *Cygnus ferus;* and the × in *Cavern* column against *Falco;* and the × against *Gastornis Parisiensis* in the *Eocene* column; the × in the *Pliocene* column against *Cygnus ferus.*

REVIEWS.

Geological Observations on South Australia, principally in the district South-east of Adelaide. By the Rev. J. E. Woods, F.G.S., etc. 8vo. Longman. 1862.

We have in this book the results of an amateur geologist's well-directed observations on the geological structure of a considerable portion of South Australia during his residence there as a missionary, actively employed, and both willing and able to find occupation and amusement, during his leisure hours and solitary rides, in studying nature and the physical features of the country. The chief geological feature of the south-eastern portion of South Australia is a wide-spread limestone, mostly white and friable, composed largely of Bryozoa, especially of a large Cellepora (*C. gambieriensis,* Busk). The upper part of the limestone is often compact and without fossils, and it passes by degrees into the lower softer bed, which is full of Bryozoa, Terebratulæ, Pectines, and other bivalves, with numerous Gasteropods (chiefly casts), several Echinoderms, Shark-teeth, etc. The author gives a full account of this limestone, its flint-layers, iron-pyrites, rock-salt, and fossils; and remarks that, though it has some characters in common with the white chalk of England, yet it is really to be compared with the Suffolk Crag. He ascribes the origin of this deposit to a great reef, or reefs, of Bryozoa, such as have given given rise also to the Maestricht chalk and the Crag of Suffolk; but in explaining the natural history of such a reef, Mr. Woods has very unfortunately confounded "corallines," "corals," and "moss-corals" (partly by intent, and partly for want of exact zoological knowledge), to such an extent, that few of his non-scientific readers (to whom he particularly addresses himself) will understand that "corallines" are really stony seaweeds or algæ; corals, humble animals, but little raised above the sponge families; whilst moss-corals or Bryozoa (termed also Polyzoa) rank higher in the animal scale, and belong to a very different group. The external resemblance of certain Bryozoa to corals, long ago led some geologists to regard the lower Crag of Suffolk as being made up of "corals," and to give it the name "Coralline,"—a word which already had another meaning in connection with the calciferous Algæ. As neither corals nor corallines occur (or but very rarely) either in the Suffolk or the South Australian Crag, "coralline" must be a misnomer for either of them; and we hope that Mr. Woods will recollect this if his work comes to a second edition, as we hope it will. Some of the fossils of the white limestone under notice are illustrated by indifferent woodcuts; we trust that Mr. Woods will find some opportunity of having all his fossils carefully figured and determined by some working palæontologist. Mr. Busk has examined and named some of the Bryozoa (p. 84); the Foraminifera have been determined by Mr. Jones, of the Geological Society (p. 71); and Professor M'Coy seems to have examined others of the fossils; Mr. Woods, therefore, has made some progress in the elucidation of the palæontology of the interesting formation which has occupied his attention with such good results as the book before us bears witness to. This book, written far away from libraries and museums, at Penola, in the South Australian bush, not only gives evidence of its author's good judgment in choosing geological research as means of intellectual amusement, of his extensive reading, his acuteness of observation, and sensible generalizations, but it is a good example of what may be done in rendering a geologist's knowledge of one locality available to neighbours and to the world at large. Without aiming at a high scientific standing (for which indeed its many verbal errors in nomenclature, and its scientific shortcomings, unfit it), this work will do good service both in the Colonies and at home. "In the former, the number of scientific readers is comparatively few, though in no parts of the world perhaps is a greater interest felt in matters of the kind," says the author; and indeed, what with their gold-seeking, water-seeking, and coal-seeking, their search for building-materials, their road-makings, etc., our colonial brethren may well have occasion to be alive to scientific subjects, and to geology in particular.

There is very much relating to the extinct volcanos of South Australia, and to the caves and their bone-breccias, to be found in Mr. Woods's interesting book; for all of these have their place in the geological history of the limestone tract which the author more particularly works out. In the late Tertiary period the Bryozoa had it all their own way here, in a hollow sea-bed, and rivalled corals in the accumulation of extensive reef-like deposits of calcareous matter, until volcanic agency interfered for awhile, to be succeeded by the deposits of shelly matter by ocean-currents for a long period, followed by a perhaps longer era of upheaval and slow denudation, accompanied by other volcanic disturbances; the extinct craters due to this are still existing. The upheaved Bryozoal limestone weathers into arid sand; it is also extensively excavated by subterranean water-channels, supplying the local wells to a large extent.

These changes have been gradual, the author thinks; and during that long time the marine fauna was considerably changed, but the terrestrial fauna in a less degree.

The author has some useful observations, in his early chapters, on the relation of physical geography to geological conditions, and on the general physical character of Australia. His description of the soil, swamps, vegetation, and faunal peculiarities of the district in which he interests himself, affords many useful hints to the palæontologist as to local accumulations of minute organisms, of certain lake-shells, and of mammalian bones. The "Biscuits-flats" of Southern Australia have long puzzled those who have seen them; but Mr. Woods explains the origin of the calcareous "biscuits," by showing that these round flat plates are really the sun-dried marly cakes that have been formed in little depressions of the ground in the rainy season (p. 45).

We hope that this highly interesting and well-constructed work will fulfil its object as an instructive book among the public fully as well as it served, whilst in preparation, to amuse its solitary, hard-working author in the Bush.

Studi Stratigrafici e Paleontologici sull' Infralias nelle Montagne del Golfo della Spezia; del Prof. Giovanni Capellini. 4to. Bologna. 1862.

The Lower Liassic formations of the neighbourhood of Spezia have been long interesting to British geologists, the labours of De la Beche and Murchison having rendered them to a certain extent familiar to us. The excellent memoir which Prof. Capellini has produced gives an elaborate catalogue of the fossils of the *calcare nero,* and the associated schists of the vicinity.

COMPARATIVE TABLE OF THE PRINCIPAL LOCALITIES OF THE SPECIES OF MOLLUSCA COMMON TO THE LOWER LIAS OF SPEZIA.

Species met with in the hills of the Gulf of Spezia, and the neighbouring islands of Palmaria, Tiro, and Tiretto.	Lombardy.	Hettange.	Rodano.	Ardèche.	Isère.	Moselle.	Semur, Côte d'Or.
Ammonites nanus ?, *Mart.*	...	...	...	...	...	...	*
Purpurina spediensis, n. sp.	...	...	...	...	...	...	...
Neritopsis tuba, *Schafh.*	*	...	...	...	...	...	...
N. Paretii, n. sp.	...	...	...	...	...	...	...
N. bombicciana, n. sp.	...	..	...	...	...	...	...
Chemnitzia usta, *Terq.*, sp.	...	*	...	...	...	...	...
C. abbreviata, *Terq.*, sp.	...	*	...	...	...	...	...
C. turbinata, *Terq.*, sp.	...	*	...	...	...	...	...
C. unicingulata, *Terq.*, sp.	...	*	...	...	...	...	...
C. incerta, n. sp.	...	...	...	...	...	...	...
C. Cordieri, n. sp.	...	...	...	...	...	...	...
C. acutispirata, n. sp.	...	...	...	...		...	..
C. Lessoniana, n. sp.	...	...	...	...	...	...	...
Cerithium semele, *Mart.*	...	...	*	...	*	*	*
C. Henrici, *Mart.*	...	...	...	...	...	...	*
C. rotundatum, *Terq*	...	*	...	...	...	...	...
C. gratum, *Terq.*	...	*	*	*	*	...	...
C. Meneghinii, n. sp.	...	...	...	...	...	...	...
C. sociale, n. sp.	...	...	...	...	...	...	...
Turritella Dunkeri, *Terq.?*	...	*	*	*	*	...	...
T. Zenkeni, *Terq.*	...	*	...	...	...	...	...
T. Deshaysea, *Terq.*	...	*	*	*	*	..	...
T. bicarinata, n. sp.	...	...	...	...	...	...	...
T. Somervilliana, n. sp.	...	...	...	...	...	...	...
T. lunensis, n. sp.	...	...	...	...	...	...	...
Turbo subpyramidalis, *D'Orb.*	...	...	...	...	...	...	...
Phasianella nana, *Terq.*	...	*	*	*	*	...	...
P. Guidonii, n. sp.	...	...	...	...	...	...	...
Orthostoma Savii, n. sp.	...	..	...	...	...	...	...
O. triticum, *Terq.*	...	*	...	...	...	...	...
Corbula imperfecta, n. sp.	...	...	...	...	...	...	...
Anatina præcursor, *Quenst.*, sp.	...	...	...	...	...	...	...
Pholadomya sp.	...	...	...	...	...	...	...
Myacites faba, *Wink.*	*	...	...	...	...	...	...
Mactra securiformis, *D'Orb.?*	*	*	...	...	...	...	...
Astarte cingulata, *Terq.*	...	*	...	...	...	...	...
A. Cocchii, *Mgh.*	..	...	...	...	...	...	...
A. Pillæ, n. sp.	...	...	...	...	...	...	...
Cardinia regularis, *Terq.*	...	*	*	*	*	...	...
C. trigona, *D'Orb.*	...	...	...	...	...	...	...
C. angulata, n. sp.	...	...	...	...	...	...	...
Total	3	14	6	5	6	1	3

Species met with in the hills of the Gulf of Spezia, and the neighbouring islands of Palmaria, Tiro, and Tiretto.	Lombardy.	Hettange.	Rodano.	Ardèche.	Isère.	Moselle.
Brought forward	3	14	6	5	6	1
Cardinia Stoppaniana, n. sp.	...	...	...	...	...	...
Myoconcha psilonoti, *Quenst.*	...	...	...	...	...	...
Cardita munita, *Stopp.*	*	...	...	...	...	...
C. Austriaca, *Hauer*, sp.	*	...	...	...	...	...
C. tetragona, *Terq.*	...	*	...	...	...	...
Lucina Civatensis, *Stopp.*	*	...	...	...	...	...
Corbis depressa, *Romer*, sp.	*	...	...	...	...	...
Cardium Regazzonii, *Stopp.*	*	...	...	...	...	...
Myophoria lævigata, *Bronn*, sp.	...	..	...	...	...	...
Cucullæa acuta, *Mgh.*, sp.	...	*	...	...	...	...
C. Murchisonii, n. sp.	...	...	...	...	...	...
C. Castallanensis, n. sp.	...	...	...	...	...	...
Nucula subovalis, *Gold.*	*	...	...	...	...	...
N. ovalis, *Ziethen*	...	...	...	...	...	...
N. strigillata, *Gold.*	...	...	...	...	...	...
Mytilus cuneatus, *Sow.*, sp.	..	...	...	...	...	...
Lithodomus Lyellianus, n. sp.	...	...	...	...	...	...
L. Meneghinii, n. sp.	...	...	...	...	...	...
Avicula Deshayesi, *Terq.*	...	*	...	...	...	...
A. Buvignieri, *Terq.*	...	*	...	...	...	...
A. Dunkeri, *Terq.*	...	*	...	...	...	...
A. Alfredi, *Terq.?*	...	*	...	...	...	...
A. infraliassica, *Mart.*	...	...	...	...	...	...
A. Sismondæ, n. sp.	...	...	...	...	...	...
A. Meneghinii, n. sp.	...	...	...	...	...	...
A. inæquiradiata, *Schafh.*	*	...	...	...	...	...
Pecten Falgeri, *Mer.*	*	...	...	...	...	...
P. janiriformis, *Stopp.*	*	...	...	...	...	...
P. aviculoides, *Stopp.?*	*	...	...	...	...	...
P. Sismondæ, n. sp.	...	...	...	...	...	...
Lima punctata, *Sow.*	*	*	...	...	...	...
L. Azzarolæ, *Stopp.*	*	...	...	...	...	...
L. nodulosa, *Terq.?*	...	*	...	...	...	...
L. præcursor, *Quenst.*	...	...	...	...	...	...
L. pectinoides, *Sow.*, sp.	...	...	...	...	...	...
Spondylus Hoffmanni, n. sp.	...	...	...	...	...	...
Plicatula interstriata, *Emm.*	*	*	*	*	*	...
P. Mortilleti, *Stopp.*	*	...	...	...	...	...
Rhynconella Pillæ, *Mgh.*	...	...	...	...	...	...
R. Portuvenerensis, n. sp.	...	..	...	...	...	...
Total	17	23	7	6	7	1

The following table of the divisions of the Lower Liassic beds in Italy, France, Belgium, England and Germany will be found useful.

		TERQUEM. (Paléont. Luxemb.)	MARTIN. Infralias Côte-d'Or.	English Geologists.	HAUER, SUESS, etc. (Various works)	ESCHER. (Geol. Bemerk.)	STOPPANI. (Paleont. Lombarda.)	CAPELLINI.	
								On the Gulf of Spezia.	In the Apuan Alps, Monti Pisani, etc.
Lias		. . . . . . *Calc.* à Gryphées arquées.	. . . . . . *Calc.* à Gryphées.	. . . . . . Limestones, *G. arcuata* and *A. Bucklandi.*	. . . . . . Starhemberg-Gres tener-Schichten.		. . . . . Formazione di Saltrio.	Lias. Schisti calcarei nerastri con Belemniti.	Lias. ?
LOWER LIAS BEDS.	Upper.	*Grès calc. ou grès d'Hettange et de Luxemb. (Pierre bise ou foie-de-veau de Martin).* *Calcaire grèso-bitumineur.*	Zone à *Amm. Moreanus*, Foie-de-veau.	White Lias, with *A. planorbis* and *A. Johnstoni.*	Dachsteinkalk.	Kalk mit *Megalodon scutatus*, Schaf.	Dolomia superiore di Lombardia.	Calcare dolomitico e marmo portoro dei monti Castellana, Coregna, Murlo, Rocchetta, ecc.	?
	Lower.	*Bone-bed.* Grès cristallin micacé ou grès de Helmsingen et de Lœvelange.	Zone à *Amm. Burgundiæ*, Lumachelles.	*Bone-bed* of Axmouth, Austcliff, Watchet, Wainlod cliff, etc.	Kössener-Schichten.	Oberes. S. Cassian.	Deposito dell' Azzarola e banco madreporico.	Calcare nero e schisti fossiliferi di Grotta Arpaja, Tiro e Tiretto.	Calcare fossilifero della Tecchia, ecc., delle Alpi Apuane. Calcare grigio-cupo senza selce fossilifero di Caprona, Asciano, S. Giovanni alla Vena nei Monti Pisani.
			Zone à *Avicula contorta*, Arkoses.				Gruppo delle lumachelle e degli schisti neri marnosi.	Calcare grigio e schisti a Bactryllium del Pescino, Parodi. Calcare fettucciato, Bianca; schisti a Bactr.	
Upper Trias .		Marnes irisées.	Marnes irisées.	(Keuper-) New Red Marl.	Dolomite. Hallstätter-Schichten (Esino Kalk). Raibler-Schichten and S. Cassianer Schichten (Lombardia).	Hauptdolomit. Petref. von Esino. Keuper (Letten-kohle. Bunte Mergel.)	Dolomia media. A. Dolomia media propriamente detta. B. Petrific. d' Esino. C. Gruppo di Gorno e Dos-	Calcare cavernoso di S. Benedetto, S. Bartolommeo, Bianca, etc. Breccia di schisti del Verrucano, a S. Terenzo, Lerici,	Calcare cavernoso. ?

Geologia e Paleontologia del Bolognese; Cenno Storico del Prof. G. Capellini. 8vo. Bologna. 1863.

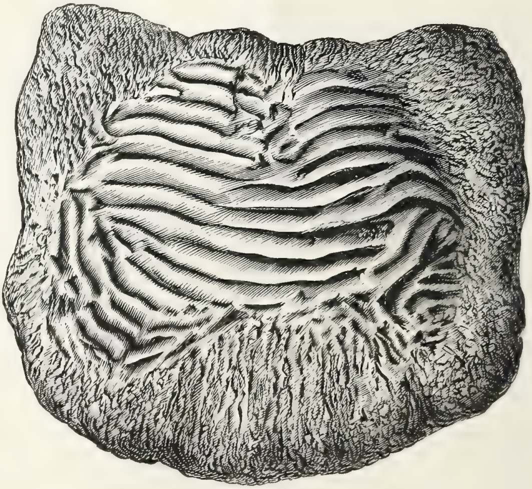
This is a history of the progress of geology and palæontology in the neighbourhood of Bologna from 1648 to 1810. The Aldrovandine Museum first gave an impetus to the study of palæontology in Italy, and many of its choicest specimens were described by Ambrosini in his 'Museum Metallicum.' Here under the name of *Argyroconchus* was for the first time figured a fossil shell frequent in all the Bolognese hills, which Scheuchzer in a later period termed *Concha polygynglima,* Lamarck *Perna maxillata,* Deshayes *Perna Soldani.* Lorenzo Legati in a part of his work (1677) denied that the Glosso-petro had formed part of an animal, but elsewhere admitted its resemblance to the tooth of the shark. The labours of Ghedini, Beccari, and Monti are alluded to by Prof. Capellini, as well as the researches of Dr. Falconer, who has shown the distinction between the rhinoceros of Monte Biancano (*R. leptorhinus,* Cuv. part) and the species from Val d'Arno described as the *R. Etruscus* of Falconer.

The memoir is of a most interesting nature, and although the present political condition of Italy is such as to inspire but little hope for scientific progress there, the above-mentioned works by Prof. Capellini are valuable and accurate contributions to this science.

Balenottera Fossile nelle Argile Plioceniche di S. Lorenzo in Collina (Provincia di Bologna). Nota del Prof. G. Capellini. 8vo. Bologna. 1862.

This little pamphlet details the progress of a journey made, and brief notices of the fossils collected by Professor G. Capellini, Drs. Foresti and Nicolai, in the neighbourhood of Bologna. The most striking fossil which was obtained was referable to the genus *Rorqualus,* of which a portion of mandible, being about a metre and a half in length, was at first discovered, and led to the identification of the species. Afterwards the skull, the maxillary bone, and one of the mandibles, doubtful evidence of a paddle, and portions of vertebræ and ribs, were found. Deductions from these evidences lead Professor Capellini to the inference that the whale to which it belonged measured at least 68 feet in length. He speculates on the future discovery of the remains of dolphins, rhinoceroses, elephants, and other mammalia that inhabited the same region during the Pliocene epoch. In a note he reminds palæontologists that besides remains of rhinoceroses which exist in the museum at Bologna, there is also a fine molar of *Elephas antiquus,* derived from Crovara, and which forms part of the fossils collected by Professor Alessandrini. A few fragments, referable to the same species, from the same locality were discovered in a shop, where a piece of a broken mandible had also been preserved in a bad state.

We are glad to see that Professor Capellini is endeavouring to remove the stigma which has been cast upon Italian geologists, of not paying due attention to the productions of their own country.



PTYCHODUS POLYGYRUS, Agassiz.

From the White Chalk of Kent.

[In the Collection of N. T. Wetherell, Esq., of Highgate.]

S. J. Mackie del.

THE GEOLOGIST.

MAY 1863.

CESTRACIONT FISHES OF THE CHALK.

BY THE EDITOR.

THE very fine specimen of palatal tooth of *Ptychodus polygyrus*, which we figure in Plate IX., from the collection of N. T. Wetherell, Esq., of Highgate, temporarily draws our attention to a class of remains of very considerable interest.

We have not the leisure at the present time for going as deeply into the subject as it well deserves, nor as the mass of valuable materials accumulated since the publications of Agassiz in 1843, and Dixon in 1850, require.

There are also other important points than the mere bearings of more detailed information of the characters of species very possibly to be gained by a study of the singular and marked group of cestraciont fishes. First known, in abundance of individuals, in the Carboniferous age—though not at any time numerous in genera,—and presenting various forms, numerically abundant, in the Jurassic and other intermediate formations up to the Chalk, characterized by its many varieties of Ptychodus, but now dwindled down to a solitary representative in the Port Jackson shark, it is one of those very circumscribed groups in which we ought to find more especially and distinctly marked traces of the transmutation of one species into another, if such transmutation did exist in the past ages of our planet. That the group does present important evidence on this point is certain, but whether sufficient or not to come to a practical and definite conclusion, may be as yet doubtful; although, if collectors will turn to the fossil remains of these fishes in earnest, we may rest assured of good work in this direction being done. By a glance at the British Museum specimens, and a careful looking over of the descriptions and figures in the 'Poissons Fossiles' and the 'Geology of Sussex,' any intelligent observer would at once see what new additions would be useful for supplying the missing links in the historic and stratigraphical series. We add here a list of the species of Ptychodus exhibited in our National Collection.

SPECIES OF PTYCHODUS IN BRITISH MUSEUM COLLECTION.

PALATAL TEETH OF	
Ptychodus polygyrus . . .	From White Chalk, Burham, Kent, Wiltshire, Lewes, Sussex, Purfleet, Grays, Essex (Taylor's Collection).
Pty. depressus	White Chalk of Cherry Hinton, Cambridgeshire.
Pty., n. sp.	White Chalk (Taylor's Collection).
Pty. Oweni	White Chalk, Burham, Lewes.
Pty. Mortoni	Cretaceous strata, Clarke County, Alabama.
? *Pty.* (specimens called nascent teeth)	Lower Chalk, Dover, Sussex.
Pty., sp. (near *polygyrus*) . .	Upper Greensand, Tournay.
Pty. rugosus	White Chalk, Rochester, Greenhithe, Kent.
Pty. altior	Chalk, Sussex,
Pty. decurrens	Lower Chalk, Kent (Taylor's Collection), Harietsham, Burham, Maidstone, Kent, Brighton.
Pty. mammillaris	Lower Chalk, Lewes, Brighton, Dover, Guildford; Upper Greensand, Tournay; Chalk Marl, Töplitz.
FIN RAYS OF	
Ptychodus spectabilis . . .	White chalk, Lewes.
Pty., sp, (small size) . . .	Chalk, Sussex.
Pty. arcuatus	Chalk, Lewes.
Pty. cibberulus	Chalk, Lewes.
ty. articulatus	Chalk, Lewes.
Pty., sp.	White Chalk, Burham.
Pty. latissimus	White Chalk, Herts, Lewes, Kent, Southeram; Cretaceous deposit? at Oxford, Essex.
Pty. paucisulcatus	Chalk, Sussex.

In the same cases with the Ptychodus teeth is a tooth of *Strophodus asper*—the type specimen figured by Agassiz. There are also some other specimens and fragments of Strophodus, to which genus I am disposed to add the specimens and fragments labelled "nascent teeth of Ptychodus," and so styled in Dixon's work by Sir Philip Egerton. A comparison of the structure of one specimen in particular, with one of the specimens of *S. magnus* from the Stonesfield Slate of Eyeford, in the adjoining case will, we think, justify this view. Without wishing to do more than hint the possibility that the ancestors of *Pty. Mortoni*, from the American Greensand, may be represented in time by some of the species of Acrodus, we would invite comparison with an unnamed tooth of this genus from the Forest marble of Stanton, in Wiltshire. In the same way, if the development theory be correct, the connecting links might be hereafter discovered between the more primitive *Orodus ramosus* of the Carboniferous limestone and the Forest Marble species of Acrodus, and the *Acrodus Anningiæ* of the Lias of Lyme Regis.

NOTES ON THE EVIDENCE OF GLACIAL ACTION IN SCOTLAND.

BY P. SIMMONS, ESQ., OF WHITEINCH.

In the parish of Baldernock, county of Stirling, and in the neighbourhood of "fragments of stone reared by creatures of clay," Craigmadden Castle, the pedestrian will find three large stones well worthy of his notice. They are situated in the centre of a bog; consequently, if the said pedestrian desires to observe, measure, and minutely examine them, he must, as three friends lately did, take off boots and stockings and wade through the water that surrounds the stones to within two feet; that is to say, if he desires such articles to remain dry. The bog forms part of an extensive natural amphitheatre, situated in the Craigmadden moor; and the stones have received the name "Auld Wives' Lifts," from the absurd tradition that they were placed, once upon a time, among the heather by three old women, natives of Baldernock, Strathblane, and Campsie.

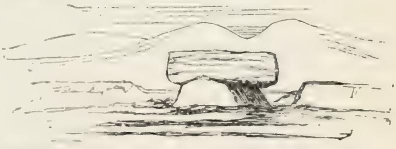


Fig. 1.—View (looking to the S.E.) of the "Auld Wives' Lifts."

The Lifts are considered by some antiquaries to be nothing more or less than a cromlech or sepulchral monument; others, however, think they are an altar which the Druids used. The former opinion is maintained by Dr. Daniel Wilson in his 'Archæology.' His words are: "It is remarkable as an example of a trilith, or complete cromlech, consisting only of three stones. Two, of nearly equal length, support the huge capstone; a block of basalt measuring fully 18 feet in length, by 11 in breadth, and 7 in depth. A narrow triangular space remains open between the three stones, and through this every stranger is required to pass on first visiting the spot, if, according to the rustic creed, he would escape the calamity of dying childless. It is not unworthy of being noted, that though the site of this singular cromlech is at no great elevation, a spectator standing on it can see across the island from sea to sea; and may almost at the same moment observe the smoke from one steamer entering the Frith of Clyde, and from another below Grangemouth, in the Forth." The view engraved by Dr. Wilson is from the south-east; and, according to his measurement, the weight of the large sandstone, not basalt, capstone is 96 tons; being 46 tons more than a different result of the measuring, which makes the weight 50 tons. The two fragments of sandstone on which this large piece rests are prismatic in shape, lying side by side, forming a triangular opening, which enables any one to creep through. The sketch of the stones as seen from the south-west, gives the reader an idea of the size of this space. In the appendix, No. 4, to Mr. Smith's recently published 'Researches in Newer Pliocene Geology,' Mr. Buchanan considers the Lifts "a very interesting and well-preserved memorial of the remote pagan people of the canoe period," and, like Nilsson, states that "the uppermost is an enormous block of basalt." This mistake causes one to imagine that the stones have not been properly examined by the said antiquaries. The Lifts are covered with the marks made by visitors and others. Their position according to the compass may be useful, and is consequently here given, as taken from the capstone.

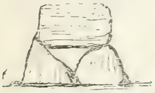


Fig. 2.—End view of the "Lifts."

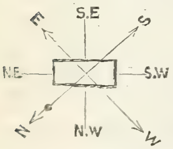


Fig. 3.—The bearings of the "Lifts."

The science of geology enables the unprejudiced observer to declare with boldness, and to prove beyond doubt, that the Auld Wives' Lifts were never placed where they now are by demons, angels, witches, or mortals, of any age. Although, to quote Kent's well-known lines,—

> "There's a pleasure on the heath
> Where Druids old have been,
> Where mantles grey have rustled by
> And swept the nettles green,"

yet science compels us to give to water and ice the honour of causing the three stones to remain where they now are. They are erratics. This fact, for the evidence is almost demonstrative, is asserted by one who has made frequent visits to the stones, and a careful examination of the strata in their neighbourhood. The former are angular; "the erratic blocks," Agassiz asserts, "in Switzerland are always angular;" the latter is composed of sandstone and conglomerate or pudding-stone. The sandstone is both polished and grooved, frequently cut and excavated by some force, doubtless ice. The ice appears to have been aided by a current, which, sweeping along, made the sandstone yield. This ice current appears to have cut the sandstone fragment lying on the margin of the bog to the south-east of the Lifts.

Fig. 4.—Sandstone block, S.E. of the "Lifts."

The stones have been floated to their present position by ice, at a time when the land was depressed by some earthquake movement. "We have," says Mr. Smith, of Jordanhill, in his most interesting 'Researches,' "in the superficial beds in the basin of the Clyde, evidences of such a movement, which must have taken place in the period when the climate was colder than at present, and which, if not paroxysmal, was sufficiently rapid to have entombed alive the testaceous inhabitants of the sea, and to have covered them up to a considerable depth with beds of finely laminated clay, which could only have been formed at the bottom of the sea." The current or rush of water made the ice bearing the erratics cut and polish the sandstone in the neighbourhood. This rush of water was doubtless produced by one of those earthquake waves thus described by Mr. Smith in the above-mentioned work, and considered by him to be the force that originated the till or boulder clay:—"A rush of water, such as that produced by earthquake waves, of sufficient violence to tear up, not only the pre-existing unconsolidated cover, but considerable portions of the subjacent rocks, and perhaps obliterate the inequalities caused by disturbances in the coal measures, passed over the island from west to east, or, rather, from the north-west, depositing the whole in a confused mass on the surface. In that part which was under the sea, beds of gravel, sand, and clay were deposited. In process of time, a second débâcle swept over the island in the same direction, but with much less violence than the first; the stratified beds, perhaps of no great thickness, were swept away, leaving, however, occasional patches sufficient to attest their existence, and also part of the pre-existing diluvium, reducing the inequalities and grinding the exposed surfaces of the rocks and boulders, for it is to this second débâcle I ascribe the scratching of the rocks and boulders; and here, I think, ice acted an important part, and was probably the principal agent in grinding down the substance over which it passed. A colder climate and a north-west direction both point to a frozen ocean, which was perhaps broken up by the convulsion which caused the diluvial wave, and the ice of which was swept over the land in the same direction." Antiquaries formerly imagined the erratics, or the boulders termed rocking stones, to be the workmanship of human hands; now however, Mr. Wright, one of the most talented of their number, asserts that they are the result of natural causes. Geology has proved this; and the same science has also taken from the territory of archæology some of the stones said to be complete cromlechs, the Lifts being an instance.

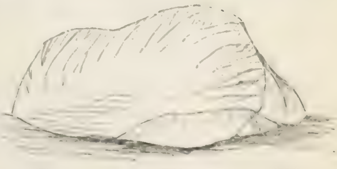


Fig. 5.—Boulder near Loch Ken.

When examining the boulders near Loch Ken in Kircudbrightshire, I observed among many of great size and gigantic in composition, one 10 feet in height, and 13 feet 9 inches long, resting on two small boulders, prismatic in form. (See sketch.) Workmen were blasting some of the boulders when I was measuring, consequently their number is decreasing; and the evidence of glacial action in the neighbourhood of Loch Ken, as far as boulders are concerned, will soon cease to exist. This, however, cannot be said of the striking glacial action observed on the banks of Loch Doon, in Ayrshire, as the remarkable striated trap-rocks cannot be so easily removed. The openings or striæ are generally narrow, long, and deep; sometimes prismatic. They appear to resemble in sharpness the scratchings considered, by Dr. John Tyndall, in his published 'Description of the Glaciers of the Alps,' to be caused, on the Riffelhorn, by the Görner glacier of former ages. The boulders on the shores of Loch Doon are frequently very large, and mostly basalt; and so numerous, as to constitute entirely the west side of the loch, the waters of which appear to rest on a bed of boulders, four of which are so large as to appear above the surface, and now remain islands. (See sketch.) None of the numerous boulders examined by me possess the strong and varied polarity which Dr. Tyndall found to exist in some cast down from the summit of the Riffelhorn. It is not maintained that the many trap-boulders scattered through Scotland were never magnetic; and it is only affirmed that no fragment has yet been discovered that was observed to act forcibly upon a magnetic needle. It may be here remarked, that many of the "jutting prominences" of Dumbarton basalt rock, on which the fortress is situated, like those of the Riffelhorn and Görner Grat, described by Dr. Tyndall, possess the magnetic action caused by the magnetic oxide of iron. Has this magnetism been developed by glacial action?—is a question which cannot be here answered, although it is one worthy of being considered by geologists. The top and base of Dumbarton Rock I have examined with a small compass. Near the summit of the portion of this rock called the beacon-tower, the polarity changed, the pole affected being the south, at the distance of 34 inches. In no instance did I observe the compass to be affected in the east portion of the rock, either at the top or base; the reverse was the case with the west portion, both at the top and base, the immense fragments, undoubtedly portions of the rock, removed probably, by lightning, on the terrace at the foot of this part of the rock, being no exception to the "strong and varied polarity."

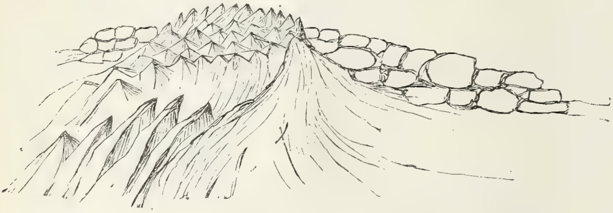


Fig. 6.—Striated basalt, Loch Doon (as seen from the Lake).

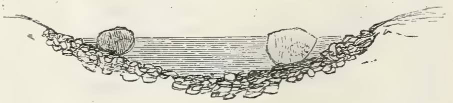


Fig. 7.—Island-boulders, Loch Doon.

Glacier pressure is considered by Dr. Tyndall to cause the crust observed on trap, or rather the species of trap termed basalt. In the 143rd page of his ‘Glaciers of the Alps,’ he says, in describing the lower spur of the Riffelhorn: “Midway down the spur I lighted upon a transverse wall of rock, which formed in earlier ages the boundary of a lateral outlet of the Görner glacier. It was red and hard, weathered rough at some places, and polished smooth at others. The lines were drawn finely upon it, but its outer surface appeared to be peeling off like a crust; the polished layer rested upon the rock like a kind of enamel. The action of the glacier appeared to resemble that of the break of a locomotive upon rails; both being cases of exfoliation brought about by pressure and friction.” This crust is observed on basalt boulders taken out of semicircular mounds, probably caused by glacial action; portions of the crust can easily be removed. My illustrious and valued friend Mr. James Napier, F.C.S., in his valuable “Remarks on Mineral Veins and Waterworn Stones,” read before, and published in the Transactions of the Philosophical Society of Glasgow, March 3rd, 1852, has proved, beyond doubt, that this crust is not the result of pressure but of water. This eminent chemist maintains that water, in contact with and passing through rocks, changes their character, by dissolving out some of their component minerals. The following extract, although long, I cannot refrain from giving, as it clearly explains how the remarkable crust found to exist on trap or basalt rocks originates :—

“A piece of trap rock, *e.g.*, exposed to water, very soon changes, when alternately wet and dry, and exposed to the atmosphere; the decomposition is sensibly apparent, a brown crust is soon formed, which becomes soft and brittle, breaking off by slight friction, leaving a new portion of the stone to undergo the same change. The same sort of stone embedded in the gravel under the soil, passes through the same changes, but the crust in this case is not so soft and brittle; the change soon penetrates to the centre of the stone, giving it a different character and appearance.” I lately removed portions of the crust from such boulders, taken from a railway cutting in this neighbourhood, almost half an inch thick, and about 12 inches by 6. Much larger fragments could easily be obtained. “Analysis,” continues Mr. Napier, “of the stone so changed, compared with the original, makes the change very apparent. We give the average of many analyses from different localities :—

Kernel, or original stone.			Crust, or altered stone.		
Insoluble silicate of alumina	66·8		Insoluble matter	72·5	
Protoxide of iron	18·5	Fe 14·4	Peroxide of iron	19·7	Fe 13·8
Lime	3·8		Lime	0·9	
Magnesia	1·5		Magnesia	0·3	
Potash	2·6		Potash	trace	
Loss at red heat, water	6·2		Loss at red heat	5·1	
	99·4			99·2	

“Here, then, we find that water has dissolved out lime, iron, magnesia, and potash, and the remaining iron changed to the peroxide state. The length of time required for the water to penetrate a piece of trap I know not; but that the soluble power of the water is great, is evident, by placing a piece of such rock in distilled water; 100 grains digested for six days, at summer heat, lost one per cent.: the water had an alkaline reaction, and contained magnesia, potash, and lime." Mr. Napier exhibited a specimen of a boulder, showing "the powerful action constantly going on in the earth, changing the character of rocks;" and he also remarks, that "the crust or outer portion of stones of this soil have generally been looked upon as incrustations, from the water in which they have been placed having salts in solution that have become deposited upon the stone or kernel portion. Such incrustation does take place upon organic substances placed in mineral waters; but in this instance, as in most other minerals, the change has evidently been caused by the decomposition of the original stone."

Not far from the town of Lochwinnoch, on the road to Kilbarchan, in which parish it is situated, stands one of the most remarkable erratics in the west of Scotland. Mr. William Fulton, M.A., Govan, first informed me of its existence, and last July both of us measured it. The immense basalt fragment, judging from the direction of the deep and broad scratches on its south-east side, appears to have been carried along in two directions; the force, either ice or running water, thus causing the marks or scratches to cross one another almost at right angles. (See sketch.) The stone is 11 feet in height and about 69 feet in circumference, and appears to be two miles west of the town of Kilbarchan. The stream called St. Bride's Burn is not very far from the erratic, which receives the local name Clochodrickstone, said to be from the Gaelic, meaning the Druid's stone.

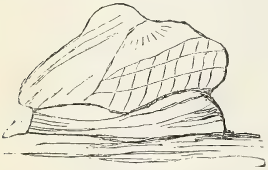


Fig. 8.—Erratic block, Lochwinnoch.

AN ATTEMPT TO CORRELATE THE GLACIAL AND POST-GLACIAL DEPOSITS OF THE BRITISH ISLES, AND TO DETERMINE THEIR ORDER OF SUCCESSION.

By Professor William King,

Of the Queen's University, Ireland, and the Queen's College, Galway.

The classification given in the sequel is based on the following premises:—

1st. The entire area of the British Isles has undergone at different times, during the Glacial and Post-Glacial periods, a succession of secular elevating and subsiding movements.

2nd. At the close of the Pliocene period, the relative level of land

and sea over the British area was approximately the same as at present.

3rd. The edge of the two-hundred-fathoms submarine plateau, on the east side of the North Atlantic, formed the west coast-line of a continent (now represented by Europe) during the earliest time (epoch) of the Glacial period.

4th. The climate of the British area was frigid in the extreme during the Glacial period, allowing epochs of amelioration.

5th. Rock-surfaces undergo enormous degradation when they are above the sea-level, during the prevalency of glaciation.

General Observations on the above.

1st Premiss. Besides the great vertical movements which characterized the Glacial period, there are evidences, hereafter noticed, that it was marked by minor vertical oscillations. Further, it is probable that the former were not of equal magnitude over the entire area of the British Isles; land might be standing somewhat higher or lower in the east than in the west; the same difference may have prevailed meridionally.

2nd. The "Cromer Norway Spruce-forest" bed evidently formed a land-surface at the close of the Pliocene period; while the overlying "Runton *Leda myalis* clay" shows that the forest-bed became afterwards submerged. Further, the shells occurring in the Runton deposit may be accepted as a clear proof that the sea in which they lived was Arctic in its temperature; the same may be affirmed of the "Norwich Crag" sea. There is no novelty in these conclusions. Doubtless the elevated regions of the British area, during the prevalency of the Pliocene Arctic temperature, were undergoing glaciation. It is equally admissible that the then German Ocean was traversed by icebergs, transporting blocks from northern latitudes. These considerations lead me to assume that the foreign erratics, common in the unstratified drift or till of the north of England and the more southern counties, are *Pliocene* in age, and that they afterwards became mixed with lowland accumulations of field- and mountain-glacier débris, formed during the earliest division of the Glacial period, that is, when the bed of the German Ocean was all a terrestrial surface. I doubt that any Pliocene foreign erratics are anywhere to be seen under their original form of accumulation.

3rd. My late investigations on the soundings obtained by H.M.S. Porcupine* have convinced me that the remarkable rapid-sinking edge of the two-hundred-fathoms submarine plateau, forming the Irish seabed, as well as the extension of this edge, both north and south, has been cut away by the North Atlantic when its waters were confined within the bounding meridians of the two-miles-deep submarine plain, across which it is proposed to run the telegraph cable from Ireland to Newfoundland. Geological evidences go far to prove that the above oceanic conditions prevailed in the earliest epoch of the Glacial period. Mr. Godwin-Austen has already enunciated a similar opinion.*

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* See my papers in the 'Nautical Magazine' of November and December, 1862 (a corrected copy of which appeared in the 'Daily News' of December 24, 1862); also my "Reply to Dr. Wallich's Statements," Naut. Mag., March, 1863.

The Irish submarine plateau is bounded by sloping sides, which generally sink down to about 10,000 feet, or nearly 1700 fathoms, before reaching the general level of the plain alluded to, with an inclination ranging from 400 to 1000 feet in the mile; the lowest being off Galway (Hoskyn), and the highest on the coast of Kerry, where, however, there is also a 548-feet incline. The surface of the plateau appears to be marked by three terraces of different levels. *First.* The outer edge of this, the lowest terrace, is not naturally defined by the 200-fathoms line, as one of the names of the plateau seemingly implies, but rather by one of 220 fathoms; as it is from the latter line that the most sudden descent is made into deep water. *Second.* This terrace is limited by the 115-fathoms line, there being here a well-marked break, before reaching shallow water. *Third.* In passing from the last line to the shore, we meet with a rise about the 35-fathoms line. It is not well defined; but there appears to be rather an abrupt ascent from 45 to 35 fathoms. When these terraces were subaerial, the *first* was probably upwards of 1300 feet above the sea, the *second* nearly 700 feet, and the *third* upwards of 200 feet.

The vertical movements assumed as having taken place in subsequent *epochs* of the Glacial and Post-Glacial periods are in a great measure based on the present premiss.

4th. The first epoch of the Glacial period is generally admitted to have been the coldest. It is my belief that the then British area, with all the land now beneath the German Ocean, also that forming the Irish "two-hundred-fathoms plateau," was shrouded with an enormously thick pall of field- and mountain-glaciers. My views on this subject are in no respect less *ultra* than those advocated by Agassiz and Ramsay. Probably during the earliest portion of the next or subaqueous epoch, the climatic conditions were not much less rigorous: the removal of blocks from low to high levels, in the way suggested by Darwin, requires the coasts to have been thickly girded with ice, like the shores of east Greenland and other Arctic lands at the present day. The close of this epoch appears to have been affected by a somewhat milder climate, which continued into the third (or second subaerial) epoch. If I am right in ascribing, with Agassiz and Lyell, the origin of the Glen Roy terraces to a glacier lake, it may be inferred that the last stage of this epoch enjoyed a still more ameliorated climate; probably ending with a mean temperature more or less resembling that now prevailing in the British Isles.

5th. While I quite agree with Ramsay as regards the powerful degradation which the rock-surfaces of the British area underwent during the Glacial period, I must also contend, from what has already been stated under the first of my premises, that our elevated regions were considerably eroded by glaciers during the close of the Pliocene period.

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* Quarterly Journal of the Geological Society, vol. vi. p. 86. I formed the opinion before learning that Mr. Godwin-Austen had advanced a similar one.

Before entering on the next subject, it is necessary for me to mention that I wish the greater part of the insertions in the table to be taken in an approximate sense; a few of them, such as "Irish Round Towers," are offered suggestively.

Remarks on the Phenomena of the Glacial and Post-Glacial periods noticed in the Table.

The two periods under immediate consideration are strongly differentiated both by their physical and organic features. It is unnecessary to add more to what has already been stated on the former. The Glacial period was characterized by the presence of species of the genera *Elephas*, *Rhinoceros*, and *Hippopotamus*, doubtless as amply protected against a severe frigid climate as the Bear, Walrus, Musk Buffalo, Balene Whale, now inhabiting the ice-bound regions of the Arctic Circle. The Post-Glacial period appears to have been always marked by the absence of the genera above named, at least in the area of the British Isles. The shells special to the glacial period are such as still inhabit the Arctic seas: a few, but very few, may have become extinct. Whether any new species have come into existence during the Post-Glacial period is a question which I am unable to answer; but it would appear that a few are special to this term, if we confine our observations to the British and adjacent seas,—the following species, *Lima excavata*, *Haliotis tuberculata*, *Fusus Berniciensis*, and *Litorina litoralis*, being unrecorded in Glacial and Pliocene deposits. The genus *Homo* belongs to both the glacial and post-glacial period: it was represented as early as the close of the subaqueous epoch or the beginning of the second subaerial division of the Glacial period by a low form or extinct species,—a view strongly countenanced by the Neanderthal skeleton, as well as the rudely-chipped flint-implements occurring in the elephant gravels of Amiens, Hoxne, and other places. Probably a higher type existed at the same time, as indicated by the skulls found in the Engis caves near Liége. The "Borreby people" of the Post-Glacial period appear to have descended from the Neanderthal race. How far back in geological time it was that the genus made its first appearance on our planet is a question yet to be solved. There is no reason, however, to doubt that it was represented by species during the Pliocene, or even the Miocene period.

The line of demarcation between any two epochs, also between the Glacial and Post-Glacial periods, I assume as being formed by terrestrial and oceanic conditions corresponding to the present relative level of land and sea.

Glacial Period.

First (subaerial) epoch.—The elevation of the British area, although the land is assumed to have been thirteen hundred feet (=220 fathoms) higher than it is at present, is not, in my opinion, to be regarded as the cause of the severe climatic conditions of this epoch.

Our present genial temperature, as correctly remarked by Lyell, is exceptional, and it appears to be in some measure due to the Gulf Stream; but, as maintained by Ramsay, some general cause must have operated in producing the extreme frigid climate of the Glacial period, considering that it prevailed over an immensely wide geographical area, irrespective of the area being successively under continental and oceanic conditions, as it was during the first and second epochs. Apparently, the climate was somewhat less rigorous towards the close of the second epoch, and during the one to which I shall next advert.

Second (subaqueous) epoch.—I have considerable doubt that terrestrial, fluviatile, or littoral animal life existed, except very partially, in the British area under the severe conditions of temperature of the first (subaerial) epoch; and I am disposed to apply a similar doubt to the *early* division of the one under consideration. This is the reason why I have excluded fossiliferous deposits from the two stages respectively forming the *close* of the subaerial, and the *beginning* of the subaqueous epoch.

The shells found by Trimmer on Moel Tryfaen (1400 feet in height), and named by Forbes, do not positively indicate an Arctic climate; but this may be accounted for on the supposition that the deposit containing them is of littoral origin. Deposits formed, contemporary with the "Moel Tryfaen Shell Drift," at the bottom of a deep sea, would contain shells of a decidedly Arctic character. At the present time, the littoral zone of the west coast of Ireland is tenanted by southern species (*Diodonta fragilis*, *Avicula Tarentina*, *Circe minima*, etc.); while in the comparatively deep water (100 fathoms) of the plateau, already noticed, there occur the following subarctic species, *Leda pygmæa*, *Limopsis aurita*, *Macandrevia cranium*, etc. The "Airdrie (Lanarkshire) *Tellina calcarea* clay" may be regarded as the equivalent in geological time of the "Moel Tryfaen Shell Drift;" but formed in deep water.

The removal of blocks from low to high levels, in some cases several hundred feet, by the action of shore ice on a gradually subsiding coast may be referred to the first half of the epoch, though I am disposed to think that the same phenomenon, but on a smaller scale, was also produced by land ice during the preceding epoch.

The remarkable broad terraces, deeply cut out of limestone beds (Carboniferous), characterizing the waving slopes of the Clare Hills (1000 feet in height) on the south side of Galway Bay, have evidently been formed, as the land rose out of the sea from a depth of not less than 1000 feet: every terrace indicates a stoppage in the uprising.* It is impossible to conceive that these terraces were formed in the subsiding stage of this epoch, or during any portion of the preceding one: there is also considerable difficulty in the way of supposing that they were produced in the Pliocene period, inasmuch as they could not have escaped being planed down and obliterated in the first epoch of the Glacial period. The glaciers of this last period, I am led to believe, have mainly contributed in giving the Clare Hills, before they became terraced, their leading contours. It does not appear that the terraces, considering their well-defined edges, were affected to any extent by the glaciation of the epoch next to be noticed, except perhaps in the valleys (which run down the slopes), where they are only faintly exhibited.*

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* I noticed these terraces at the Dublin meeting of the British Association, in 1857, in connection with the remarkable jointing associated with them. An abstract of a paper, which contained a further notice of this jointing, is given in the British Association Report of 1857. Professor Jukes has also noticed the terraces and jointing of the Clare Hills in his 'Manual of Geology,' 2nd edit., 1862.

Some of the freshwater deposits which I have placed in the opening stage of the next epoch may belong to the closing stage of this epoch. The land was evidently undergoing minor oscillations at the time, as shown by Prestwich, in his description of the section at Shacklewell Lane, West Hackney, which "affords a clear indication of two gravel periods, separated by an interval of dry land."* I see no reason to doubt that the large earth-crust movements, characterizing the "epochs" of the "Glacial period," were ocasionally accompanied by minor oscillations.

The "Brighton ancient sea-beach" could not have existed earlier than the close of this epoch, otherwise it and its protecting cliff would have been swept off by the powerful glaciation of the previous (subaerial) one.

Third (subaerial) epoch.—The Clare Hill terraces have evidently been more acted on by ordinary atmospheric agencies than by glaciation: it is, therefore, difficult to adopt any other conclusion than that the glaciers of this epoch were smaller than those of the former (subaerial) one. Ramsay has formed the same opinion from other evidences. Still the glaciers of this epoch must have had considerable power to scour the "old marine drift" out of Cwm-llafar, and to deeply erode the rocks of the Brixham, Gower, and Wookey-hole districts. Prestwich has shown that much of the "Biddenham flint-implement gravel" has also been removed by glacial agency. All these phenomena appear to me to be geologically contemporaneous, and, of course, subsequent to the formation of the gravel last noticed. This deposit, however, does not seem to have been formed by the agency of ice, although the one may have indirectly contributed to the formation of the other. A question next arises—What gave rise to the glaciers which scooped out the "Biddenham flint-implement gravel," and effected the other erosions above alluded to? Were they produced by an elevation of the land? or are they to be attributed to some other cause—the land remaining at its old level? Although unable to adduce any positive evidence in favour of either of the views involved in these questions, I am, nevertheless, inclined to adopt the one which admits that the second glaciation arose, in the districts named, and in the British area generally, in consequence of a great but gradual elevatory movement, which stopped when the *second* or 115-fathoms terrace of the Irish submarine plateau became elevated above the sea. Considering, however, the diminished

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* Journ. Geol. Soc. vol. xi. p. 110.

TABULAR VIEW OF THE GLACIAL

		MARINE TYPES.
POST-GLACIAL PERIOD.	Subaqueous. (Land about 25 feet below its present level in middle stage—*b*.)	*c*. Foraminiferous mud (calcareous) now forming in the depths Atlantic.—Deposits forming around British coasts. *b*. Glasgow canoe-sands. *a*. Shell-sands overlying Carnon and Pentuan (Cornwall) silt, taining human remains (Colenso).
	Subaerial. (Land probably 200 feet above its present level in middle stage—*b*.)	*c*. *b*. Dogger-bank *Mya truncata* bottom (King). (The land being at a higher level than it is at present, no deposits could be formed on it.) *a*.
	Subaqueous. (Land probably 300 feet below its present level in middle stage—*b*.)	*c*. *b*. Belfast *Thracia convexa* clays (Hyndman).—Probably such raised beaches as contain only existing British shells, *e.g.* rush (Antrim),—especially of Scotland (Landsborough, ford, Jeffreys). *a*.
GLACIAL PERIOD.	Third (Subaerial) epoch. (During the middle stage, *b*, the land possibly reached an elevation of 700 feet or more above its present level.)	*c*. *b*. (Much of the bed of the German Ocean above the sea.— England, and Ireland connected.) *a*. *Astarte arctica* bottom, off Fern Isles, Northumberland (Kin
	Second (Subaqueous) epoch. (During the middle stage, *b*, the land was probably upwards of 2000 feet below its present level.) Erratic blocks (many foreign) transported by icebergs during the entire epoch. Blocks transported from low to high levels. Formation of Clare Hill terraces.	*c*. Pagham (Sussex) "marine gravel" (Godwin-Austen).— (near Hull) *Natica clausa* gravel (Phillips, Prestwich).— wood Park (Sussex) shell gravel (Prestwich).—Brighton nish, and Devonshire raised beaches.—Howth (Dublin) *Cy* *Chione* gravel.—Wolverhampton *Astarte arctica* gravel (L Lancashire erratic-block-shell drift (Gilbertson, Murc Binney).—Wicklow, Londonderry, and Antrim *Leda oblong* (Portlock, Oldham).—Pagham (Sussex) "yellow clay wit nite blocks" (Godwin-Austen).—Kyles of Bute *Pecten Is* *cus* clay (Smith, of Jordan Hill). *b*. Moel-Tryfaen (Caernarvonshire) shell drift,—littoral (J. Trin —Airdrie (Lanarkshire) *Tellina calcarea* clay,—pelagic (*a*.
	First (Subaerial) epoch. (During the middle stage, *b*, the land probably attained an elevation of more than 1300 feet above its present level. No part of the British Isles beneath the sea during the entire epoch.).	*c*. *b*. (The bed of the German Ocean and the Irish Atlantic 200-fa submarine plateau subaerial.) *a*.
PLIOCENE PERIOD. (Latest portion.)		Bed of German Ocean strewed over with Scandinavian iceberg ported blocks, which frequently afterwards, especially in next became mingled with British field-ice drift; thereby produci mixed unstratified till of north of England.—(See column of La Freshwater deposits, Glacial period.)—? Pagham (Sussex) *L* *rugosa* mud deposit (Dixon).—Runton (Norfolk) *Leda mya* (J. Trimmer).

POST-GLACIAL DEPOSITS, CHIEFLY BRITISH.

LAND AND FRESHWATER TYPES.
c. Peat, marl, and other deposits, now forming in lakes, rivers, etc. *b.* *a.* ? Irish round towers.—Egyptian pyramids.
c. ? Stonehenge. Carnon and Pentuan (Cornwall) silt, containing human remains (Colenso). *b.* Cardigan Scotch fir submarine forest (Yates). Irish submarine peat bogs. (? Dogger-bank and much of the German Ocean above the sea. Ireland and Spain united: present Asturian flora of S. and W. of Ireland, the remnants of that union.) *a.* ? In Denmark, "Borreby people" living.
c. *b.* Kiltiernan (Co. Dublin) Reindeer deposit (Oldham). Irish upland forests. Irish and Isle of Man *Megaceros Hibernicus* marls (Forbes). *a.*
Formation of Glen Roy gravel terraces. *c.* Menchecourt (Valley of the Somme) low-level flint-implement gravel (Estuarine).—Mundesly (Norfolk) *Hydrobia marginata* beds (Lyell).—Brentford (Thames) mammaliferous gravel (Morris).—River Air (Yorkshire) Hippopotamus alluvium (Denny). *b.* Last glaciation of British Isles, during which Caernarvonshire "marine drift" was scoured out—Cwm-llafar, Nant Francon, etc. (Darwin, Ramsay); old unstratified till swept off land surfaces and rearranged (Escars); Brixham (Pengelly), Gower (Falconer), and Wookey-hole (Dawkins) rocks, with ossiferous fissures, eroded; also high-level flint-implement gravels of Biddenham, Amiens, and St. Acheul, in part washed off.—Copford (Essex) "brown clay with boulders" (Brown). *a.* Copford (Essex) *Helix incarnata* marl (Brown).—Infilling of Brixham (Devonshire), Gower (Glamorganshire), Wookey-hole (Somersetshire), and other ossiferous fissures.—St. Acheul and Amiens high-level flint-implement gravels.—Cropthorn (on the Avon) *Cyrena consobrina* alluvium (Strickland).—Hoxne (Suffolk) and Biddenham (Bedfordshire) flint-implement gravels.—Grays (Essex) *Unio littoralis* bed.
c. Cromer contorted drift (Lyell). *b.* (No subaerial surfaces within the area of British Isles, except highest mountains, (Lyell, fig. 39, p. 276.) (Subaerial surfaces much decreased; as represented by Lyell, 'Antiquity of Man,' fig. 40, p. 287.) *a.* ? Muswell Hill (near London) drift.
c. Much unstratified till, formed in preceding stages, eroded and rearranged.—Copford (Essex) "grey gravel with boulders" (Brown). *b.* Highest and lowest regions enormously glaciated, the resulting débris (unstratified till) often becoming mixed with the Scandinavian iceberg-transported blocks of the Pliocene period, especially in the area of the German Ocean (not in existence at this time).—Much of the surface-features of the British Isles formed. Antrim basaltic plateau in many districts deeply eroded; formation of valleys of the Thames, Severn, Tyne, Tees, etc. *a.*
Highest mountain-regions of British Isles under glaciation. Cromer (Norfolk) Norway spruce-forest bed.

size of the glaciers of this epoch, it may be inferred that the land did not attain the altitude it had during the preceding (subaerial) one. Possibly the land, as indicated by the depth of the *second* terrace, never rose more than 700 feet beyond the level it stood at when the "Biddenham flint-implement gravel" was in course of formation, that is, about the present relative level of land and sea. Probably the field-glaciers were wholly, or to a considerable extent, melted in the summer months, thereby giving rise to extensive land-floods. According to this view, the rocks of the then upland plains [enormously abraded in the first (subaerial) epoch] would again be ground down by glacial action in winter;* while in summer, the torrents of water arising from melted ice would sift the glacier débris, piling its blocks, pebbles, and sand into banks (Escars) and mounds, and sweeping the mud into adjacent lakes and seas. This last glaciation would remove or destroy many of the marine deposits formed in the "subaqueous epoch:" hence their scarcity. The Lancashire and Warwickshire shell-deposits have escaped its destructive power.

I quite agree with Prestwich in referring the flint-implement gravels of the Seine and the Somme to two distinct epochs, between which great physico-geographical changes took place.† The oldest (or highest) of these gravels appears to have its counterpart in that occurring near Biddenham. I am not able to correlate any British flint-implement gravels with the youngest (or lowest) occurring at Menchecourt and other French localities; but it is highly probable that some of those recently discovered by Prestwich, Evans, Whitaker, and others are the equivalents in geological time of those forming the lowest series at the mouth of the Somme.

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* The flat country lying between Dublin and Galway would, under the conditions named in the text, form an upland plain. From all I can observe, the district around Galway has been covered with subaerial drift (formed during the first glacial epoch) of not less than 300 feet in thickness; I find patches of it lying at a height equal to the number of feet mentioned at Tonabrocken. Much of this drift, in my opinion, has been considerably worn down completely or swept away, at the close of the first and in the middle of the second subaerial epochs. On the worn-down undulating surfaces of this old drift, erratic blocks of granitic rocks, etc., are common: these, I consider, have been transported by, and dropped from, icebergs during the subaqueous epoch of the glacial period. Much information on the subject of Irish drifts and erratics is given by Du Noyer in his highly interesting paper, published in the 'Geologist' of last July. Notwithstanding its original great thickness, the singular fact is common around Galway, that in no case where the limestone has been denuded of the subaerial drift do the wide cracks and joints prevalent in the rock contain a particle of it: one would have imagined the very contrary. I can only account for its absence on the view, advanced in the text, that the limestone, on which the drift was originally deposited, has, in addition to the degradation which it underwent towards the close of the first (subaerial) epoch, been much abraded by the winter glaciation of the third (subaerial) one; thereby exposing beds which were not uppermost when the drift was in course of deposition.

† Apparently Mr. Prestwich does not go so far in the views stated as I do. All the evidences bearing on the physico-geographical changes noticed in the text show that the intervening time, between the epochs to which the two series of flint-implement gravels are referred, was of enormous length. The Rev. Mr. Symonds correctly observes that the physical geology of the oldest or highest of the Somme valley gravels "proves their immense antiquity even more than do their fossil remains." (Geology of the Railway, p. 14.)

The formation of the gravel terraces of Glen Roy appears to have taken place in the last half of this epoch—when the land was subsiding. Had they existed previously, they must have been obliterated by glaciation. Nothing affords a better explanation of their origin than the view originally advanced by Agassiz, and lately adopted by Lyell, that they were formed in a valley converted into a lake by the damming up of its mouth with a glacier which descended from Ben Nevis. Admitting that the Glen Roy terraces have been formed in this way, it must be conceded that the land was at the time gradually yet intermittently subsiding. While the subsidence was going on, it may be safely assumed that the glacier-dam became more and more reduced in height, causing at the same time the level of the lake. water to fall lower and lower, until, finally, both glacier and lake disappeared altogether. Possibly the melting of the glacier was facilitated by the gradual setting in of the more genial climatic conditions which prevailed in the succeeding epoch. It is unnecessary to suppose that the land, when subsiding, descended beneath its present level in the last stages of the lake and glacier.

The way in which the glacier-lake of the Märjelen-see is formed and sustained, that is, by the glacier of Aletsch, as described by Ramsay, may be accepted as a good illustration, on a small scale, of the origin of the old glacier-lake of Glen Roy.

Post-Glacial Period.

First epoch (subaqueous).—There are several mountain bogs in the west of Ireland containing the remains of rooted trees which could not, under present conditions of temperature, grow at their present elevation. I am strongly inclined to believe that they grew at a lower level. The "Belfast *Thracia convexa* clay" may have been deposited about the same time in deepish water.

Second epoch (subaerial).—During this epoch, considerable portions of the submarine area between the south of Ireland and the coast of Spain, and averaging about 200 feet in depth, was elevated above the level of the sea, giving rise to a land-surface which botanically connected these two countries. The connection, although now physically severed, is still maintained, as Forbes noticed in 1846, by the presence of Asturian plants—*Dabeocia polifolia*, *Pinguicula grandiflora*, *Arabis ciliata*, *Trichomanes radicans*, etc.—in Kerry and Connemara. Forbes conceived that the "destruction of the intermediate land took place before the Glacial period;"* but since he wrote, the researches of Ramsay, Prestwich, Lyell, Trimmer, Godwin-Austen, Jamieson, Falconer, Pengelly, Chambers, and numerous others, in Post-Pliocene geology, render it highly probable that the "destruction" occurred at a much later period; in short, that Ireland, England, and Spain were united during the earliest age of tin-mining in Cornwall.

In numerous places on the Irish coast there occur extensive submarine peat-bogs, which, it is evident, cannot have been formed when the forests last noticed were growing as supposed, or at the present relative level of land and sea. They must have been formed when the land was higher than it is at present,—perhaps not more than 200 feet. These submarine peat-bogs may have been formed contemporaneously with the shell-deposit next noticed.

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* Mem. Geol. Survey, vol. i. p. 348.

Some years ago, when dredging on the west side of the Dogger Bank, off the coast of Durham, in about 50 fathoms water, the dredge brought up a large quantity of dead specimens, in a chalky condition, of *Mya truncata* (Annals Nat. Hist. vol. xviii. p. 233). It is impossible to conceive that these specimens of a littoral species lived at the depth from which they were procured; nor can I admit that they have been transported from a shallower habitat by marine currents. There is less difficulty in contending that they lived on the spot which yielded them, when the Dogger Bank was a subaerial surface; and that the species ceased to live in the locality when the land became submerged.

Third epoch.—Influenced by the investigations of Geikie, also by some considerations given in a notice which I have elsewhere published ('Parthenon,' No. 50, April 11, p. 417), I am led to believe that the "Glasgow canoe-sands" are not so ancient as some archæologists have conceived. Possibly some portion of this deposit may be of high prehistoric antiquity; but evidently some of it was formed when Scotland was occupied by the Romans.

Admitting the view just stated to be correct, it necessarily follows that the geological epoch under consideration includes the historical era of our country. A question now suggests itself—Are the slight vertical movements of the Post-Glacial period equal in chronological value to the much larger ones of the Glacial period? Or another—Are they simply equivalents of the minor oscillations which accompanied the great movements of the latter term? Considering the magnitude of the physico-geographical changes which characterized the Glacial period, as compared with those of the following one, I feel most inclined to adopt the view comprehended in the last question. In this case it may be contended that the Post-Glacial period has not yet advanced beyond its initial stages.

SPECULATIONS ON POSSIBLE PHYSICAL AND COSMICAL PHENOMENA IN REFERENCE TO THE PAST CONDITIONS OF OUR EARTH.

By S. J. Mackie, F.G.S.

Whenever we begin to think about the formation of the universe we get at once into the realms of speculation, and the only value of our thoughts rests in their probability. In everything unknown we must first form an idea—that is, speculate; then, by partial gatherings of facts, or by positive reasoning, we may theorize. Ultimately, by the accumulation of evidence, we may prove that which, in the first place, we only imagined. When first men observed the sun, they regarded the earth as a flat plain, over which the sun passed in his heavenly course, and below which, at eve, he retired to rest. It was not until many ages had elapsed that the world came to be regarded as round, and even then it was long before the sun was considered as a fixed centre of the planetary system revolving round him.

By no nation of ancient times has astronomy been more advanced than the Greeks. Not that the Greeks ever *worked out* much to a proved result, but they were an imaginative people, and they invented notions. If one theory or speculation was disproved, they invented another; and, hit or miss, they always seemed to have fresh ideas in reserve. In some things astronomical, as in many other things that the world believes in, we may be heretics, and we admit we do not adhere to all the cosmical, physical, geological, and spiritual tenets of the popular faiths. We may not entirely believe in the perfect stability of the universe; we may doubt the eternal endurance of the sun's bright rays; and we may not quite acquiesce in the unchangeable permanence of the planetary orbits: in short, we do not believe in the *permanence* of anything whatever in creation. All ever *has been* change, and changeful all things ever *will be.* Diversity and change are visible in the first created things of which any relics have been left us. Diversity and change are palpable in every living creature and every inanimate thing around. The foreshadowings of future changes fall everywhere and on everything. Never, in all the Great Past, do we find a ledge of stability on which to rest the mind's weary flight; nor in all the future can we spy one solitary changeless rock on which to seek repose. The mind, like the fabled flight of the gorgeous birds of paradise, is doomed to endless effort,—from birth to death to be ceaselessly on the wing. It is a fashion, however,—and has been more so than it is now,—to talk about the stability of the universe. Nothing is, ever was, or ever will be, *fixed* in space. Not even the "fixed" stars, for we know they are all *in motion;* and the spectral analysis of the light of some, at any rate, shows that those whose rays we can analyse are in a state of combustion—burning like our own sun. Notwithstanding the sublime edict for the creation of light in that Bible most people profess to believe, we suspect strongly that most people regard the light of our sun as eternal. If eternal in the future, why not eternal in the Past? If not eternal in the past, why eternal in the Future? Not that we think such arguments always bear.

The mind naturally clings to the idea that creation began; and the more educated, the more competent, the more reflective the mind becomes, the more it clings to the conviction that creation *did* begin. But having begun, having progressed, still progressing, who will dare to think it shall ever cease? Such a thought involves the extinction, death of the Creator. Never! More glorious and more powerful day by day, and age by age, the Almighty Strength may grow and increase, but diminish, cease,—never! But, back to our point. Has the sun shone for ever in the backward Past? Certainly not! Will it light up for ever in the endless future the vast and glorious space its beams illumine now? Perhaps not. The sun may go out—it may be millions of years to come ere it does, but its light may some day be darkened. It is a long time to look forward to when *that* will happen, we admit, and the race of man may pass away like the many life-races of the Past, long before the bright rays of that "glorious orb" begin to fade. But change is everywhere; we see it in everything around us; we read the record of change everywhere and on everything in the Past. The first land, so far as we can make out, differed from our dry land now; the first plants differed from those that clothe the dry land now; the first living creatures differed from the animated beings around us. Fish, flesh, nor fowl put on the same bodies; perhaps even air and ocean differ. How, then, were the planets weighed to a grain and forbidden to increase? Were their distances measured off to a millimetre, and the irrevocable order passed, "Nearer shalt thou not approach, further shalt thou not recede from the burning sun"? For the sun was the edict passed, "Without increase or waste, burning shalt thou go on for ever and ever"? Such an edict would make the sun an eternal *creator* of force. And no one believes in *creation* except from God. Who but He, in the incomprehensible beginning of all things, created the first atom of force, and has gone on unceasingly multiplying force upon force ever since?

It is well even in this world now and then to go out of the beaten paths and to explore new lands—if even the result be only to convince us of the value of the old ones. It is well, too, in science now and then to diverge on to the realms of speculation—if even only to attain a conviction of the accuracy of that which has been accepted. At one time we had too much of speculation and too little of facts, but in the advancing sciences of late, perhaps we have had too many facts and too few speculations. Bricklayers would make of bricks but a poor edifice if the architect had not imagined the building beforehand. We all know how Physical Geology, as a science, is looked at in the ordinary way; and no one who looks closely at the picture presented for our acceptance as the portraiture of what was, what has been, and what has happened, but must think that the picture offered has many flaws. The artists claim pre-Raphaelite minuteness and correctness in its execution; they profess to have studied facts, and to have built their picture up scene by scene, leaf by leaf, texture for texture. We do not condemn *their* pre-Raphaelite painting; but we claim the artist's right to let *our* fancy loose, and to sketch out imaginary pictures of our own.

Let those who have gone before us claim veracity for their depictions, we ask only that ours may be looked upon as fanciful scenes; but if in our visionary sketchings the tracery of truthful expression be detected, do us then the justice to let *that* be treasured and preserved. Our task is not to upset an old school and found a new, but to seek out Truth.

For this purpose, then, we commence in this article a series of speculations on possible physical and cosmical phenomena in reference to the past conditions of our Earth, not always with the intention of proposing new views or even our own opinions, but as often putting hypothetical cases to learn what would have been the results produced by particular conditions of physical forces and the exertion in particular directions of cosmical laws.

At this lovely spring-time of the year, the bright warm beams of the shining sun cause our eyes to rise to the blue and cloud-mottled sky. All around, the green buds are shooting forth, and flowers blossoming and perfuming the balmy air. What would this beautiful world be without that sunshine? What would indefatigable, active man be without these cheering, life-exciting beams of the orb of day? The sun is but a great fire; fire, we know, consumes the substances it feeds upon; gigantic as the solar orb may be, the fire must burn it out, and, like the dark stars that astronomers now have indicated, the time may come when the earth, changed, perhaps, itself to a burning mass, may reveal by its luminous beams to the astronomers of distant worlds its revolutions round an unseen, dark, extinguished sun. But without so deep a dive into the mysteries of time to come, let us ask ourselves what would be the effect of minor alterations in the solar fire? We cannot believe the solar flames are always burning at exactly the same height, with exactly the same fierceness, giving exactly the same heat, exactly the same light. The fire on our hearth flickers, blazes, grows dull, requires fresh fuel, smoulders, bursts into flame again, burns clear and ruddy, glows with radiant heat, darkens, chinkles, and goes out. The consumption of the solar fire must be supplied; we cannot believe that as particle by particle is consumed, particle by particle is supplied. Even if meteors supply the sun, they must vary in abundance at different periods of time. If worlds fall in occasionally to supply the waste, the solar fires at that spot must slacken, deaden, to glow out again bright and more furiously when the new fuel is ignited through. For geological purposes, without going into *great* variations of the solar fire, let us conceive two modifications,—one of 15° increase of temperature from such a cause, and one of 15° decrease. We are told the centre of the earth is a burning incandescent fluid mass,—rather an uncomfortable idea, and not quite intelligible. We are taught it, however, mainly because the fossil relics of former creatures and plants are *supposed* to indicate tropical conditions in latitudes where now temperate conditions prevail. Unfortunately, however, in digging down into the bowels of the earth we do not find the temperature increase more and more with the depth, the heat increase faster and faster as we get nearer and nearer to this imaginary central melting-pot; we do not, in short, find the heat of the handle increase more rapidly as we pass from the knob to the red-hot end of the poker. Just as Glaisher going up in the high regions of the air has disproved the old doctrine of a supposed decrease of one degree of heat for every 300 feet of vertical height, and found a gradually diminishing scale of loss, 1°

for the first 100, and so on until above three miles and a half it takes a thousand feet to lose the required degree of heat,—so geologists, instead of getting even a regular correspondence of 1° Fahr. loss for every 63 feet of depth, find a gradual divergence in the ratio of vertical depth to loss of heat, and at one mile down have to go more feet to get it. And let it not be forgotten that these results have been given us by men who are pledged to the opposite view, who would rather not have known these truths, and perhaps would have hid them if they could. It is possible, then, that other causes than internal heat may have caused a former higher temperature of the globe. But more of this anon. Suppose now the other case—that the average temperature of the whole earth was 15° less than it is now. What would be the result? Glaciers in Wales and Scotland again as once there were before; ice-floes in the valley of the Thames and on the Norfolk shores driving up the beds of sand and mud into contorted strata, such as we have in the Mundesley cliffs; and icebergs dropping—if the ocean-currents flowed on as once they did—boulders of Scandinavian and other foreign rocks on the midland counties and the northern regions covered by the Glacial drift.

Miller has shown the heat of the sun to be not more than 14,580° Fahr.,—the heat of the oxy-hydrogen flame,—and probably it is not much less. Now the surface of the sun is given as 12,500 greater than the earth's, and, therefore, taking the earth's surface as unity, we have the proportion of 12,500 to 1.* If, therefore, assuming for convenience the temperature of the sun as 12,500° (instead of 14,580° Fahr.), we suppose our earth to fall into the sun, without igniting on its external side, the total amount of heat radiated from his surface would evidently be 12,499°, or reduced by the size of the earth by one unit of heat, giving the surface the equivalent of one degree of heat.

But as the sun presents only one side to us, a loss of radiation of heat to the extent of two degrees would take place on the side of the sun to which the non-radiant earth was attached. As the sun however rotates on its axis in 25 days, every alternate fortnight or thereabouts the total temperature of the solar rays would be 2° Fahr. less than in the intervening periods. Now Tyndall speaks of the earth receiving but the $\frac{1}{2300000000}$ part of the solar rays, and therefore it might be said that the falling in of the earth would only reduce the temperature of the earth by that part of a degree; but, on the other hand, we should have to consider what influence such an event would produce if the point of collision and obscuration was in a direct line with the earth. In such a case the direct light- and heat-rays would be shut off, and although compensated for in a great degree by the convergence of the surrounding rays in the great flood of light coming away from the sun, a considerable effect might be produced on the temperature of the earth. Of what effect might be produced we have perhaps some examples in the actual effects produced by sun-spots. Single spots often appear of dimensions equal to and exceeding that of our earth, and periodically we have numerous congeries of spots of sufficient importance to produce disturbances at any rate of the magnetical conditions of our globe if not indeed to produce any distinctly perceptible diminution of temperature. That the latter effect might not be readily determinable in the converging or fluctuating states by our atmosphere is by no means surprising; but it should be borne in mind that Arago and other astronomers have asserted and attempted to prove that the maximum periods of sun-spots are regular decades of colder years. Such minute changes as those produced by these minor differences in the amount of materials in actual conflagration would have had little effect on the general climatal temperature of our earth, but if a difference, no matter how small, could in this or any other way be proved, it would be a basis for real conclusions on the subject. There are, however, five other ways in which the solar rays might affect the general climatal conditions of the earth. 1. The mass of the sun being larger or smaller would radiate more or less heat accordingly. 2. There might be maximum and minimum periods of conflagration. 3. The extent of the earth's atmosphere might influence climatal condition by the conversion by friction of the light rays into heat, just as light rays falling on a black surface are arrested, annihilated, converted into heat, which they are, and on the same principle that a falling bullet striking the ground has its velocity or motion changed into an equivalent of heat. 4. A former higher and lower rate of rotation of our own globe would have important effects upon the climatal conditions and on the vegetation and life of our planet. 5. Variations in the dimensions of the orbit of the earth.

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* Considerable confusion of ideas and a want of logic will be attributed to me in these articles if it be not distinctly borne in mind that I adopt popular ideas and popular phraseology *only for the moment*, and that it is *not intended* to work these speculations into any *definite theory*. If any definite conclusions be arrived at, they will be given as *corollaries* to these speculations, and not embodied in them. For example, we speak now upon the dictum that the volume of the sun is 1,400,000 greater than the earth, its mass being as 354,936 to 1, and its diameter as 882,000 to 8000, or 111½ times greater than the earth. This gives the sun a mean density four times less than the earth,—a point we shall presently discuss, as it is very questionable if we ought to take the visible face of the sun, and his apparent size, in determining his density, because heated to the extent of nearly 15,000 degrees, and having, as astronomers declare, an exterior luminous photosphere; and, as Kirchhof and Bunsen have shown, a still exterior atmosphere of luminous incandescent metallic vapour. The light-exhausted internal nucleus of burnt-out and probably solid material of the central core of our luminary is what we ought to consider as the actual globe of the sun, and which is what we should properly estimate for his mass and density, at any rate for purposes of comparison with our earth.

(*To be continued.*)

ON CHELONIAN SCUTES FROM THE STONESFIELD SLATE.

By C. Carter Blake, Esq.

In the British Museum there are several specimens of "papilionaceous" flattened bodies exhibiting six or more concentric lines radiating from two nuclei on either side of an elevated medial line. The stone in which they are embedded is unquestionably the Stonesfield slate; it contains the characteristic *Trigonia angulata*, *Rhynchonella*, *Ostrea*, and *Modiola Sowerbyana*, D'Orb. (= *plicata*, Sowerby). The enigmatical bodies to which I now allude are stained of a deep red-ferruginous colour, the matrix retaining the grey tint and crystalline texture of the Stonesfield slate. On comparison between these remains and those of the specimens of *Geomyda spinosa*, from Singapore, in the British Museum, presented by Sir A. Smith, a comparison which was suggested to me by Mr. Davies, whose accurate discrimination first threw light upon the nature of the present evidence, I have been led to consider that the specimens in the Fossil Gallery represent the second, third, and fourth median scutes of a tortoise allied to the recent African species. The fossils and their corresponding impressions from the Stonesfield slate afford, according to my interpretation, evidence of the texture of the horny scutes which were developed outside the bony carapace of the old Oolitic tortoise. A particular interest is attached to these specimens, as they were considered by the late Edward Forbes as Trigonellites, or opercula of Ammonites.

Since the above was written, I learn that Dr. J. E. Gray, several years ago, considered the present evidences to be Chelonian. I am indebted to my friend Mr. S. P. Woodward, F.G.S., for this information, and am now aware that the true signification and interpretation of these remains has been known to him for a long period.

CORRESPONDENCE.

Holoptychius v. *Glyptolepis*.

Dear Sir,—My notice of the Dura Den Glyptolepis, in your number for March last, was merely intended to correct an impression which Mr. Mitchell's paper in your February number seemed calculated to convey, namely, that it was he who first pointed out the propriety of transferring *Holoptychius Flemingi* from the genus Holoptychius to Glyptolepis. In doing so I seem to have expressed myself so loosely as to make it appear that I claimed for myself and others the merit of first noticing the crescent of points on the scales of that fish. This I by no means intended to do, as I was well aware that these had been long before observed; indeed a glance at the figure given by Agassiz in his 'Vieux Grès Rouge,' pl. 22, fig. 1, will show that this peculiarity had not been overlooked by him. I was also aware that Professor Pander had expressed his belief that the scales of *Holoptychius Flemingi* and *Glyptolepis leptopterus* were the same; these I consider specifically distinct. But lest I might seem to claim too much, I forwarded to you a note to be added to my letter, which seems to have arrived too late for insertion, and which, by some strange mistake, has been printed in your number for this month (April) as the first paragraph of a communication from the Rev. W. S. Symonds. I may add that Mr. Page, of Edinburgh, was the first to point out, in my hearing, the existence of Glyptolepis scales in the Dura Den Sandstones.

Mr. Davies, in his communication in your April number, refers to the greater imbrication of the scales "mentioned by Mr. Mitchell" (no new discovery), and also to the general character of the ridges on the scales, as being differently and distinctly marked in the two genera. Undoubtedly, retaining the old nomenclature, the scales in *H. giganteus, H. nobilissimus,* etc., are less imbricated, and have the ridges more wavy and boldly marked than in *H. Flemingi,* but on examining a large collection of the Dura Den fishes, a pretty regular gradation from the less to the more imbricated and from the bold wavy ridges of the larger species to the almost parallel and delicately marked lines found on the scales of some of the others, may be traced. Mr. Davies's remark as to the position of the scales showing the crescent of points scarcely corresponds with my experience, but this may very probably be occasioned by our observations being principally confined to different species. In *H. Flemingi* many scales on every part of the body sufficiently preserved and exposed, which I have yet examined, show the crescent of points, while in other species these are only to be found on the scales along the flanks.

I am very glad to learn from Mr. Davies that the characteristic specimen of *Holoptychius Andersoni* in the British Museum shows, what I have been unable to detect in that species, the crescent of points,—as this is a considerable step towards clearing up the dispute Holoptychius *v.* Glyptolepis. Professor Huxley states in his introductory Essay to the X Decade of Plates published in connection with the Geological Survey (p. 9), "The clear recognition of the fact that this elegant structure really characterizes Glyptolepis is of great importance, for . . . it enables one to discriminate between Holoptychius (*whose scales have no semilunar area of backwardly-directed points*) and Glyptolepis."

I have to express my gratification at the notice Mr. Davies takes of these communications; to local geologists situated at a long distance from collections affording facilities for comparing the many species of such genera, and ever comparing nearly allied genera with one another, such hints as he gives are very valuable indeed. I am, dear Sir, yours truly,

JAMES POWRIE.

Reswallie, April 10th, 1863.

Bones at Macclesfield.

DEAR SIR,—You obligingly inserted a paper from me in Vol. IV. of the 'Geologist,' and the following communication may perhaps interest some of your readers:—

A few days ago, in levelling a piece of ground as a site for an infirmary, a few bones and a molar tooth were discovered by the workmen. Thirty feet below, there is a small brook, which runs into the river, distant about a quarter of a mile, at a further decline of about 70 feet. The bones were embedded a little apart from each other, in a layer of fine sand about 18 inches in thickness; above that there was a deposit, about 2 yards in depth, of coarse sand and gravel, thickly studded with large waterworn pebbles of the Primary, with a few of the Secondary sandstone rocks. About 18 inches of soil (alluvium) surmounted the whole. The excavation was continued about 2 yards below the bed of sand in which the bones were found, and it consisted of thin layers of gravel with marl and fine sand at irregular intervals, interspersed with carbonaceous markings and thin seams of drifted coal or shale. I have resided here many years, and the osseous remains I have sent for your inspection are the first I have seen or heard of; and, with the object of affording assistance to a solution of this discovery, perhaps I may be allowed to state a few particulars respecting the geological character, etc., of this district.

The surface immediately around Macclesfield is covered by the drift deposits, except in the valleys, where the river and its tributaries have, more or less, cut through them; and the prevailing feature of this locality, except on the eastern side of the town, is of an undulating character, consisting of mounds, inclined planes, and rounded ridges, composed chiefly of stratified sand and gravel, with an elevation occasionally of about 300 feet. The boulder clay, or till, which underlies the whole and reposes upon a lower gravel, often forms the beds of the river and smaller streams. This clay is unequally distributed in some places with respect to regularity, thickness, and extent; sometimes it approaches the surface with a depth of 60 or 70 feet, and it contains fragments of drifted coal, pieces of wood, and small boulders belonging to the Azoic and Palæozoic periods. Occasionally for yards not the smallest pebble is to be found in it. It is of a solid and tenacious quality; colour, dark-brown or slaty. The upper portion is of a more sandy nature and is made into bricks, the lower part is made into tiles, tubing, etc. Superficial patches of peat containing trunks of trees are prevalent. About a mile southward of the town, there is a large peat-bog 20 or 30 feet in depth. Here and there in the fields are to be seen erratic boulders of every size and variety. One weighing above 20 tons and of a sagenitic character was transferred to the public park a few years ago. The brick-clay had been its bed, and it was only about half covered with drifted sand and gravel.

The southern termination of the Cheshire coal-field extends to about two miles eastward of the town; and beyond that point, for about four or five miles towards Buxton, there is a large tract of high and barren moorland of the millstone grit formation. This district comprehends what is called the "Macclesfield Forest," its highest point (Shutlinglow) being above 1700 feet above the sea-level. From historic records, centuries ago this was royal hunting-ground, and abounded in wild boars, deer, badgers, otters, etc. The discovery of these bones may possibly lead to another fact, viz. that at an epoch far more remote,—the close of the Pliocene period,—the climatal conditions of this part of the island were even then favourable to the existence of at least some of the above animals, until the advent of the Pleistocene era, when the glacial drift, with its submerging effects and conflicting tides and currents, swept away their remains with other looser deposits from the higher grounds into the levels below. The otter still survives, but the last badger seen in this neighbourhood was killed about twenty years ago. It is rather surprising that the reliquiæ of the Tertiary fauna are not oftener met with, together with human relics, viz. bones, implements of war, husbandry, and the chase, especially in the gravels of these valleys.

At 70 yards deep, the coal-measures (superficially flanked by the boulder clay) are worked within half a mile of the town. They then take a north-westerly dip, both under it and the river, at a very acute angle, and are no longer available, being overlaid by the drift and probably the Lower New Red Sandstone. This remains to be investigated, and I believe there is a fair prospect of its being done this summer by officers of the Geological Survey.

Perhaps there are few parts of this kingdom which are attended with a greater variety and complexity of strata, with their apparent dislocations and disturbances, than this corner of Cheshire. Within a distance of 8 or 10 miles south and east, there are encompassed no less than seven or eight distinct geological divisions; viz. drift, Cheshire coal-field, millstone grit, mountain limestone (Derbyshire), North Stafford coal-fields with millstone grit, mountain limestone near Congleton, and the Permian and Triassic systems of Cheshire and Staffordshire. This survey has been long looked forward to, and will be hailed with pleasure and satisfaction when published. I am, dear Sir, yours respectfully,

J. D. SAINTER.

Macclesfield, April 8th, 1863.

[The bones referred to as from the gravel, which have been sent to us for examination, are, 1, metacarpal of ruminant (*Bos longifrons*); 2, calcaneum of ditto; 3, fragment of mammalian bone; 4, upper molar of ruminant (*Bos* of small size); 5, base of shed antler of red deer (*Cervus Elaphus*). This last specimen, which is but a mere fragment, seems to have the remains of a hole that had been drilled or worked in it previous to its embedment, possibly for the insertion of a celt or other instrument to which this deer's horn served as a handle. All the bones are in a porous condition, and not in any way petrified.—ED. GEOL.]

Glyptolepis.—Upper Ludlow Fossils.

MY DEAR SIR,—I beg to call your attention to an error in the last number of the 'Geologist,' at page 134. I know nothing of the claims of Mr. T. Walker as having made known the fact that *Holoptychius Flemingi* is in reality a *Glyptolepis*.* My communication to you referred simply to the detection of Keuper fossils at Ripple, near Tewkesbury.

It may be useful to some collectors if you will make it known, in a future number of the 'Geologist,' that Samuel Sturge, shoemaker, of Ledbury, has discovered a highly fossiliferous band of the Upper Ludlow bone-bed, within a few miles of Ledbury. This bed is remarkably rich in spines of fish (Onchus), and the earliest known traces of terrestrial vegetation, which are small seeds of a plant allied to the Lycopodiaceæ.

Yours very truly,

W. S. SYMONDS.

Pendock Rectory, Tewkesbury, April 4th, 1863.

Human Remains in Brick-Earth at Luton, Kent.

SIR,—I have the pleasure to inform you that a few weeks ago two skeletons were found in a brick-field near here. The soil is brick-earth, the top part for about 4 feet mingled with flint, below that the pure clay. The skeletons were found between 6 and 7 feet from the surface, one lying on the back, the other on the side, with their heads towards the north; near them was found a triangular stone weapon, rudely formed to be wielded with the two hands, its weight is 14 lbs. The skulls exhibit a very debased form, the foreheads very low and receding, the back part very large; in one the bone of the nose turns up in a very peculiar manner They are evidently of great antiquity, and have been undisturbed for very many years, for above them were the decayed roots of very large trees. The site was a large forest and hunting-ground in the reign of Elizabeth, who had a hunting-lodge in the neighbourhood, remains of which are still in existence. The skeletons were exhibited at a meeting of the Anthropological Society, held on April 7th; and the stone implement will be shown at their next meeting on the 21st. I remain, yours sincerely,

N. F. RIVERS.

Sidney Villa, Luton, Chatham, April 16th, 1863.

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* The passage referred to was, by a singular error of the printer, inserted in Mr. Symonds's letter instead of in "Notes and Queries." It was a note sent by Mr. James Powrie, of Reswallie.—ED. GEOL.

FOREIGN INTELLIGENCE.

Human remains have been reported at last from the flint-implement-bearing gravel of Abbeville. M. Boucher de Perthes announced to the Société Impériale d'Emulation of Abbeville, of which he is President, on the 16th ult., that on the 28th March last he had found in the bed of argillaceous black sand in the bank of diluvium at Moulin-Quignon, and extracted himself from the deposit, the moiety of a fossil human jaw, which at the first glance seemed to him to present some difference from the ordinary human jaw. "This jaw," so runs the extract from the *procès-verbal* of the meeting of that Society, printed in the local newspaper 'L'Abbevillois' of the 18th April, "was at 4·52 metres depth, and almost touching the chalk. At a few centimetres distance, equally embedded in the 'black bed,' was a flint-implement (*hache*), which M. de Perthes requested M. Oswald Dimpré, who accompanied him, to take out, but he could not do so without the aid of a pickaxe; M. Dimpré, sen., and five other persons were present at M. Boucher de Perthes' discovery, and saw him extract the jaw from the diluvial bed. Examined by Drs. Jules Dubois and Hecquet, and by M. de Villepoix, pharmacien,—all three members of the Société d'Emulation,—this jaw was recognized as fossil and very evidently belonging to a man, offering at the same time, as M. de Perthes remarked, some differences from the conformation of ordinary man. Since the discovery, the Abbé Bourgeois, Professor of Philosophy and Natural History at the College of Pont-le-Voie, came to Abbeville on the 10th April; Dr. Carpenter, Vice-President of the Royal Society of London, Dr. Felix Garrigou, Member of the Geological Society of France, Dr. Falconer, Member of the Royal Society of England and Geological Society of London, arrived on the 14th; M. de Quatrefages, Member of the Institute, Professor of Anthropology at the Museum of Natural History at Paris, arrived on the 15th, and have unanimously confirmed the opinion of the above members of the Society of Emulation, and declared that the jaw is fossil and truly that of a man, but that it presents some differences with the present race, as was remarked by Messrs. Jules Dubois and Hecquet, when they were consulted on that point by M. Boucher de Perthes. M. Catel, surgeon-dentist, made the same statement."

On the 11th, the diluvial deposit of Moulin-Quignon was visited by the Abbé Bourgeois, and on the 13th, 14th, and 15th by Messrs. Carpenter, Garrigou, Falconer, and Quatrefages, who, after verifying the bed and the place whence M. Boucher de Perthes had extracted the fossil jaw, have admitted that the bed is ancient and not disturbed (*remanié*), and the fossil origin of the jaw presents no matter of doubt. On the 14th, Dr. Falconer and Dr. Garrigou caused an excavation to be made in the same bed, in search of new bones. Dr. Falconer found and extracted himself, from the bed of black sand, not far from the place where M. de Perthes had found the jaw, and at 4·55 metres in depth, a flint *hache* neatly manufactured. M. Brunet, member of the Société d'Emulation, who had come to inspect the bed, witnessed this extraction. On the 15th, M. de Quatrefages having wished also to excavate this bed, had the like success as Dr. Falconer, and, pick in hand, brought out two *haches* reposing on the chalk at nearly five metres depth. Dr. Falconer and M. de Perthes were present.

M. de Perthes discovered, the same day, in the stratum of yellow sand in the same deposit, at 3½ metres from the surface, two fragments of bone that Messrs. Falconer and Quatrefages immediately recognized as fragments of mammoth tooth (*Elephas primigenius*). M. Boucher de Perthes adds, that in a mass of bones that had been found at Menchecourt, where they were found in the early part of April, at 8 metres depth, in the sand quarry (*sablière*) of M. Dufour, he had noticed a fragment of human jaw and six teeth that Dr. Falconer declared, pending the more ample examination he will give them, fossil teeth, and certainly human, but belonging to a race more allied to our own than the jaw from Moulin-Quignon. M. de Quatrefages was present.

M. Boucher de Perthes stated that he would, at a future date, communicate to the Société d'Emulation a circumstantial account of his double discovery.

For the Secretary, E. Delignières,
Abbeville, April 18th, 1863. *Vice-Secretary.*

To this account the writer in the 'Abbevillois' adds: "We learn that M. Buteaux, *ancien membre* of the General Council of the Somme and member of the Société d'Emulation, known by his fine geological works, came yesterday morning to Moulin-Quignon, and having made an excavation took himself from the diluvial bed of black sand a flint-implement (*hache*), and which was at about 5 metres in depth, near the chalk, and in the seam where M. de Perthes discovered the human fossil. M. E. Delignières assisted at this digging, as also Mr. Nicholas Brady, of London, who also extracted with his own hand a manufactured flint. M. Boucher de Perthes, in his book on diluvial antiquities, said, in 1847, that some day these antediluvian hatchets, then so rare, and the reality of which some people did not believe, would be found everywhere. This prediction is verified. He added, that it would be the same with human fossils. We are now brought to believe that in this respect also Mr. de Perthes has rightly predicted. But what has struck us above all is that he equally announced that when they did find this fossil man he would exhibit, like other antediluvian mammifers, some difference of conformation from recent individuals. The form of the jaw of the fossil man of Moulin-Quignon shows that here also he was right."

Since the publication of this account, Messrs. Prestwich and Evans have visited Abbeville, and in conversation, on their return, expressed themselves convinced that the quarrymen of Abbeville have committed an ingenious fraud, and that the flint-implements are of recent chipping, and the human bones not fossil. Later still, Dr. Falconer has published the following letter in the 'Times:'—

The Reputed Fossil Man of Abbeville.

TO THE EDITOR OF THE TIMES.

"Sir,—The asserted discovery of a fossil human jaw at Abbeville has already been noticed in the 'Times;' it has been the subject of a communication to the Royal Society, and at the present moment it is exciting the most lively interest in the scientific circles of both England and France. Having passed a couple of days at Abbeville with M. Boucher de Perthes closely examining all the circumstances of the case, and having been entrusted by him with some of the specimens, which I have now by me here, I am in a position to throw some light on the subject. The case, as a whole, presents one of the most subtle instances of perplexed evidence on a point of science that has come under my experience, and is well worthy of a hearing, from the lesson of caution which it inculcates.

"Fashioned flint-weapons, unquestionably of very remote antiquity, and as certain proofs of human agency as the watch in the illustration of Paley, have turned up in surprising abundance in the old gravel-beds of Amiens and Abbeville, but hitherto not a vestige of the bones of the men who shaped them into form. Why it should be so has remained a mystery, for human bones are as enduring as those of deer, horse, sheep, or oxen, and fossil bones of extinct animals are not unfrequent in the Somme Valley deposits. At last it was thought that the objects so long sought for in vain had been discovered. To pass over minor incidents, on the 28th of March M. de Perthes was summoned to the gravel-pit of Moulin-Quignon (described by Mr. Prestwich in his memoir in the Philosophical Transactions) to examine, *in situ*, what appeared to be a portion of bone projecting from the cliff of the section, close to its base. ('L'Abbevillois,' Avril 9.) The specimen was carefully detached with his own hands by M. de Perthes, and proved to be the entire half of an adult human lower jaw, quite perfect, and containing one back tooth,—namely, the penultimate, or last but one. The sockets of the other teeth were all present, and filled with matrix, with the exception of the antepenultimate, the socket of which was effaced, the tooth having been lost during life. The solitary molar present was hollow from caries, and crammed with matrix.

"The deposit from which the jaw was extracted is the 'black seam flinty gravel,' so called from its intensely dark (bluish-black) colour, arising from oxides of iron and manganese. It rests immediately upon the chalk, and belongs to what Prestwich calls the 'high level' series, being the oldest of the Somme Valley beds. A thin cake of black mangano-ferruginous clayey matter is interposed between the chalk and the gravel. If the jaw proved to be authentic, and came out of the alleged position, it indicated man, by an actual bone, at a period of extremely remote antiquity. The appearance of the jaw was entirely in keeping with the matrix, *i. e.* dark-coloured and fairly covered with a layer of it. A single detached human molar was found at the same time, corresponding exactly in appearance and matrix; and, to complete the case, a flint hatchet, covered with black matrix, was extracted from the same spot by M. Oswald Dunpre, who accompanied M. de Perthes. These details are all given in the 'Abbevillois' of the 9th instant.

"Two practised experts, Mr. John Evans and Mr. Prestwich, preceded me, on the 11th inst., to Abbeville, and their suspicions were instantly aroused. They pronounced the flint hatchets to be modern fabrications. I followed on the 14th, and got three of them out of the 'black seam gravel,' covered with matrix, and having every external appearance of reliability; but, on severely testing them on my return to London, they all proved to be spurious. M. Quatrefages, member of the Institute, and the eminent Professor of Anthropology in the Jardin des Plantes, got two of them in my presence from the same spot on the 15th inst. What they have proved to be I know not as yet, but I anticipate the same results. The number which turned out was marvellous, but the *terrassiers* were handsomely paid for their findings, and the crop of flint-hatchets became in like degree luxuriant.

"Now for the jaw itself. What complexion of intrinsic evidence did it yield? The craniological materials available at Abbeville for comparison were, of course, very limited; but the specimen presented a series of peculiarities which are rarely seen *in conjunction* in the jaws of European races, ancient or recent. Here I must be a little technical. 1. The posterior margin of the ascending ramus was extremely reclinate, so as to form a very obtuse angle with the ascending ramus. 2. The ascending ramus was unusually low and broad. 3. The sigmoid notch, instead of yielding an outline somewhat like a semicircle, was broad, shallow, and crescentiform. 4. The condyle was unusually globular. 5. What was most remarkable of all, the posterior angle presented what I may venture to call a *marsu-*

pial amount of inversion. The first three characters suggested to M. Quatrefages—if I may venture to cite him for a preliminary impression and not a judgment—the recollection of something corresponding in the jaws of Esquimaux, while the fifth character suggested to me the recollection of what I had seen in the jaw of an Australian savage. Neither of us had at hand the materials requisite for a satisfactory comparison, but the combination of characters above alluded to struck us both as sufficiently remarkable to demand serious examination. M. Quatrefages departed for Paris, taking the jaw with him, while I returned to London, bringing drawings and a careful description with measurements of the principal specimen, and M. de Perthes confided to me the detached molar. I may add that the jaw specimen, although professing to have been yielded from below a heavy load of coarse flints, presented no appearance of having been crushed or rolled; and that, making allowance for the crust of matrix enveloping it, the bone was light, and not infiltrated with metallic matter. The condyle washed yielded a dirty white colour.

"As to the result, I have as yet no authentic information of the final conclusions which have been arrived at in Paris. My friends, Mr. Busk, F.R.S., and Mr. Somes, F.R.S., both practised anthropologists, gave me their assistance in my part of the inquiry. The former, like M. Quatrefages and myself, was struck with the odd conjunction of unusual characters presented by the jaw, and speedily produced a lower jaw of the Australian type, brought by Professor Huxley from Darnley Island, which yielded the same kind of *marsupial* inversion, so to speak, with a nearly corresponding form in the reclinate posterior margin, ascending ramus, and sigmoid notch. But Mr. Somes's abundant collection brought the matter speedily to a point. From the pick of a sackful of human lower jaws, yielded by an old London churchyard, he produced a certain number which severally furnished all the peculiarities of the Abbeville specimen, *marsupial* inversion inclusive, although not one of them showed them all in conjunction. We then proceeded to saw up the detached molar found at Moulin-Quignon. It proved to be *quite* recent; the section was white, glistening, full of gelatine, and fresh-looking. There was an end to the case. First, the flint-hatchets were pronounced by highly competent experts (Evans and Prestwich) to be spurious; secondly, the reputed fossil molar was proved to be recent; thirdly, the reputed fossil jaw showed no character different from those that may be met with in the contents of a London churchyard. The inference which I draw from these facts is that a very clever imposition has been practised by the *terrassiers* of the Abbeville gravel-pits,—so cunningly clever, that it could not have been surpassed by a committee of anthropologists enacting a practical joke. The selection of the specimen was probably accidental; but it is not a little singular that a jaw combining so many peculiarities should have been hit upon by uninstructed workmen.

"The break-down in this spurious case in no wise affects the value of the real evidence, now well established, but it inculcates a grave lesson of caution. "Sir, your obedient servant,

"H. FALCONER, M.D., F.R.S.

"21, *Park Crescent, N.W., April 23rd.*"

The so-called fossil jaw from Moulin-Quignon has been taken to Paris by M. de Quatrefages, for the purpose of being submitted to the French Institute.

For our own part, we are indebted to M. de Perthes for his ready communication to ourselves of the intelligence of this find, and of the particulars of the deposit and the osseous remains; and we would add that if he has been made the victim of an exceedingly ingenious fraud by those workmen whom for years he has encouraged and liberally paid, we hope the proprietors of the quarry will reward their dishonesty and avarice, whenever it is brought home to them, in the summary manner they richly deserve. On M. de Perthes' side something is yet to be said; and if he has been led on by his enthusiasm to too implicit a belief in the workmen's veracity, he has kept back nothing, suppressed nothing, but has courted every publicity, and has done his utmost to secure competent witnesses for every phase of what he still considers an important discovery; if he should not in this case have that glory and good fortune he has so earnestly sought for so many years, the day will come when indeed his predictions will be verified, and we hope his life may be spared for that occasion, that his own hand shall draw forth from the gravel-beds their rare but precious proofs.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Manchester Geological Society.—*February 24th.*—Mr. Whitaker produced two horses' teeth and a flint arrow-head, which he said came out of the drift gravel at Barrowford, a few miles north of Burnley.

1. "On the Drift Deposits near Burnley," by T. T. Wilkinson, F.R.A.S. The drift deposits in the vicinity of Burnley, as well as those near Manchester, appear to possess several features of considerable importance, for, in addition to the usual clay and gravel, they contain pebbles and masses of foreign rocks, some of which are well water-worn, whilst others are so fresh and angular as to admit of scarcely any other explanation of their presence there than by iceberg-carriage from a great distance. A little east of the Four Lane Ends, near Blackburn, 650 feet above the level of the sea, the drift immediately overlies the Rough Rock, which crops out above the Corporation Park at an angle of about 75°. On the crest of this hill the blue clay, from which bricks have recently been made, lies upon the surface. It is, however, too much intermixed with sand, from the disintegration of the rock, to form good bricks. The pebbles and boulders contained in the clay appear mostly to belong to the Carboniferous formations, and their water-worn appearance indicates long-continued denuding action by water. Limestone and gannister pebbles occur in abundance; the former must have been drifted from a considerable distance.

Extensive deposits of yellowish sand occur opposite Portfield, near Whalley, 196 feet above the level of the sea; at Whittle Field, near Burnley, 451 feet above the level of the sea; and also at Healey Hall, on the slope of Burnley Moor, 580 feet above the level of the sea. Masses, or veins, of hard carbonaceous matter are occasionally found in this sand, probably indicating the remains of former vegetation; but as yet no shells have been detected in these deposits.

At the Quarry, near Habergham Hall, the sandstone rock immediately overlies the Dandy Bed of the Burnley coal-field. The surface of the rock is there covered with a coating of soft loamy shale, which soon passes into clay on exposure to the atmosphere. This shale is almost wholly composed of calamites, ferns, sigillaria, etc., indicating a profuse vegetation, which must have been covered by succeeding deposits in comparatively stagnant water. Above this shale there is a bed of dense blue clay, 22 feet thick, containing fragments of cannel coal, etc., the débris of still higher strata. Rough rock- and grit-boulders, portions of encrinital limestone, sometimes water-worn, together with rounded sandstone and limestone pebbles, occur in abundance, embedded in the clay, and the whole is surmounted by the remains of the denuded rocks which once occupied the next position in ascending order.

In the quarries near Sandy Gate, Habergham Eaves, 462 feet above the level of the sea, the drift is from 30 to 50 feet deep. It consists of dense blue clay at the bottom, and gradually passes into dark brown near the top. Large boulders of sandstone, similar to that which lies beneath, occur in these deposits, few of which appear to have suffered from the action of water. From their positions in the clay it may readily be inferred that they may have fallen from the faces of the cliffs which then probably bordered the ancient seas. Portions of encrinital limestone also occur; and there is no lack of rounded fragments of cannel, together with sandstone, gannister, and limestone pebbles.

In similar drift at Swindon, about two miles east of Burnley, 800 feet above the level of the sea, and just under the Pennine chain, large boulders of New (?) Red Sandstone are occasionally found in connection with abundance of rounded limestone. In former times the farmers have washed the drift in Swindon valley, and have burnt the limestone thus obtained in kilns, the ruins of which still remain in several places.

During the formation of a main sewer in Trafalgar Street, Burnley (1862), the workmen found a large boulder of grey granite. It was firmly embedded in yellowish clay, at a depth of about 15 feet from the surface. Encrinital limestones were also plentiful in this cutting. These deposits overlie the Thin Mine of the Burnley top beds; the cannel bed, which is the next in ascending order, having apparently been washed away.

In various localities extensive pebble-beds occur, indicating former beds of rivers, or the margins of ancient seas and lakes. Several of these bear evidences of powerful currents, which, from the set or inclination of the pebbles, appear to have flowed across the country in a N.E. to S.W. direction. This is very evident from an examination of the inclination of the débris in most of the sections previously noticed, but especially in one which exposes a portion of the grit series between Haslingden and Helmshore. This inclination of the stones, found in pebble-beds and drift deposits generally, appears to be capable of affording more information to geologists respecting currents, etc., than has yet been noted. Prior to the upheaval of the Pennine chain, a broad strait must have stretched across portions of Lancashire, Yorkshire, Durham, and perhaps Northumberland, thus connecting the present German and Irish seas; and the current through this strait must have run from N.E. to S.W., as indicated by the inclination of the pebbles and boulders in these drift deposits. Portions of floating icebergs from the north of Scotland, broken off from the edges of the glaciers, and charged with portions of granite and the older rocks, would then find their way down this channel, and becoming stranded in the shallow bays, would drop their cargoes of boulders among the silt at the bottom of the turbid waters. Red Sandstone boulders might perhaps be drifted in a similar manner from the neighbourhood of the Tees, or from the cliffs of what is now the Vale of York. Encrinital limestone, not water-worn, might also be transported from the north, by the same mode of iceberg carriage, to the deposits in which they are now found. Or again, if we adopt the conceptions of Sir Charles Lyell and Mr. Hull of the wasting of a vast North Atlantic continent, the same results would evidently be obtained.

On the gradual upheaval of the Pennine chain, the sea would consequently retire, both on the eastern and western sides of the country, leaving behind it those significant terraces which may be seen on the slopes of the hills abutting on the valleys of the Calder, the Hodder, the Ribble, and the Irwell, from about Ramsbottom to its various sources. The contents of these drift deposits also indicate several widely different conditions of things. There must have been many quiescent periods, and also many gradual depressions of the surface, during the formation of the various coal-seams, and the deposition of the rocks and shales by which they are overlaid. After the latest deposits there must have been a gradual upheaval, with occasional fractures, from the bed of a deep ocean, and, as the bottom came nearer the surface, the more powerful would be the currents, and hence the variable, but extensive denuding action of water which is everywhere apparent.

There is, however, good evidence that within the historic period the coast of Lancashire, at least, has again undergone considerable depression. In the times of the Romans there was probably no estuary of the Mersey. Ptolemy does not include this now-important opening in his topography of the coast. The dredging operations at Liverpool continually afford proofs of recent land-surface; and even hazel branches, containing nuts, were dug up from a considerable depth during the formation of the Sandon Dock. Along the shore from near Formby towards Preston, there are the remains of an extensive ancient forest. Many trunks of trees were exposed during the formation of the East Lancashire Railway, and are still to be seen in the pools on each side of the road. The roots of these are mostly below high-water mark, and in some places the trunks extend into the sea; but all of these must originally have flourished at a much higher elevation. About Southport they are so numerous, that they have been used to form ornamental fences for some of the gardens.

At Blackpool, and on towards Fleetwood, the sea is washing down the cliffs at the rate of about one yard in breadth per annum; and tradition states, on very probable grounds, that nearly half a mile, in breadth, of this part of the Lancashire coast has disappeared within the last hundred and fifty years. There are therefore strong reasons for supposing that Lancashire is at present undergoing a gradual depression. In Scotland, on the contrary, according to Mr. Geikie, the reverse operation is in progress, and it may form an interesting subject for some speculative mathematical geologist to inquire whether this apparent flexibility of the earth's crust is due to internal local action, irregularly applied, or whether it is the natural result of those mechanical laws which govern the earth when considered as a comparatively solid film resting upon a fluid interior.

In the discussion Mr. Hull said these discoveries of marine shells in the drift were very interesting; but there were also in the neighbourhood the more recent gravels of the valleys. These are of later date, and, according to the judgment of some, are most undoubtedly of the same age as the Amiens and Thames valley gravels, and many others which are yielding works of human art in different parts of Britain and the Continent; and he thought it very important that the attention of local geologists should be turned to the subject, because there is no reason, as far as we can see, why our river-terraces here should not yield flint-implements, and the remains of some of the extinct mammalia which appear to have been contemporary with man. With regard to the New Red Sandstone boulders which Mr. Wilkinson says are 800 feet above the sea, of course it would be improper to say they are not of this formation, but the identification is very questionable. He did not think the New Red Sandstone in the north of England attained to such a height. To suppose that boulders are carried from a lower level to a higher is a very unlikely thing indeed, except in the special instance of coast-ice. These sandstone boulders are much more likely to be Old Red Sandstone or millstone grit. That they have been brought from the vale of the Tees and across the Pennine chain in their course to a higher level, is extremely improbable.

Mr. Binney said Mr. Whitaker had brought some of the veritable red sandstone, which he had no hesitation in saying was millstone grit or rough rock, from the neighbourhood.

Mr. Whitaker said the ravine from which these stones have come he knew well. They are making a reservoir there, and the water-manager, at his request, brought down these boulders from the same heap that Mr. Wilkinson had examined. The course of the stream, from its source in the hills to the place at which the boulders were met with, runs over the outcrop of the millstone grit, many seams of which cannot be distinguished from these so-called New Red Sandstone boulders, but which, in his opinion, are nothing more than pieces of grit torn off and rounded by the force of the torrent; and so long as we have rocks near home that will account for these boulders, we are not warranted in going hundreds of miles away for them. If it be New Red Sandstone, it can only be found in any quantity as boulders, but it exists in any quantity *in situ* in the lower coal-measures. If he understood Mr. Wilkinson rightly, he speaks of the boulder clay having been deposited previous to the upheaval of the Pennine chain; but, from his own observations, he had arrived at an opposite conclusion, namely, that the land had much the same configuration then as now, with the exception of standing at a much lower level with regard to the sea. If, as stated by Mr. Wilkinson, the drift had been deposited upon a level plain, and the upheavals had taken place afterwards, the hills would have taken the boulder clay up with them, and we should have found it upon the tops of the highest of them. But such is not the fact. The drift can be traced to a height of from 1300 to 1400 feet, but no higher. Still, there is evidence that the sea of that time reached a height sufficient to submerge hills of from 1500 to 1600 feet. On Boulsworth, for instance, there are large numbers of enormous boulders, some of which, right on the crest of the hill, some 1600 feet high, are furrowed and grooved almost like gridirons, as if the icebergs had been stranded in floating across, and had grated upon the rocks strewn upon the bottom of the sea. But on Pendle we have an entirely different appearance. On the top we have no drift, nor any of the very large boulders that we find on Boulsworth. Growing on Pendle (1800 feet) is the semi-arctic plant *Rubus Chamæmorus*, which, according to the theory of the late lamented Professor Forbes, may be a relic of the glacial flora. The same plant may be seen on Whernside and Ingleborough, but he had not been able to meet with any traces of it on the lower ranges of hills, such as Bouldsworth or Hameldon; hence it is not improbable that hills of from 1500 to 1600 feet in height were submerged, but hills that approached to, or reached over 2000 feet, stood out as low islands in the cold and dreary sea of the Drift period.

Mr. Binney said the flint which Mr. Whitaker has now exhibited is a flint having certain chippings; and it may be taken as a moderately good example of an ancient arrow-head. It is of the same character, though rudely formed, as those which have, without question, been made artificially. It was found in the valley-gravel beyond Barrowford, and it is the very place where Mr. Prestwich and himself have been looking for them for some time. He should not like to say positively that this has been a portion of an arrow-head; but it is more like one than any other flint he had as yet seen in these beds. It is a chalk flint, and such are very rarely, if ever, found in these valleys. He thought they would be found in the gravel near Manchester.

Mr. Whitaker said about a few hundred yards further on, in the same valley, in sinking a foundation for a chimney some years ago, the workmen found several deer's horns and some bones, but they have probably been destroyed.

2. Mr. Binney read a translation of part of Dr. Geinitz's work 'On the Magnesian Limestone and Lower Red Sandstone,' by J. W. Kirkby, Esq., and himself.

Appended to the translation are the following Tables by Mr. Kirkby and Mr. Binney:—

TABULAR VIEW OF THE PERMIAN STRATA OF THE NORTH-EAST OF ENGLAND.

SUBDIVISIONS.	DURHAM.	SOUTH YORKSHIRE.
Bunter Schiefer.	*Red Sandstone* overlying the Magnesian Limestone in the S.E. part of the county?—(Howse.) Thickness,—50 ft.?	*Red Sandstone* and *Marl* near Doncaster and Tickhill—(Geol. Survey.) Thickness—50 ft.?
Upper Limestone.	*Yellow* and *Oolitic Limestone* of Roker and Hartlepool; and *Botryoidal*, *Concretionary*, and *Crystalline Limestone* of Halfway House, Building Hill, Fulwell and Cleadon Hills, and coast from Whitburn to Marsden. Thickness—250 ft.	Brotherton Limestone of Brotherton, Knottingley, Womersley, Pickburn, Loversal, Wadworth, Tickhill, etc. Thickness—120 ft.
Middle Limestone.	*Shell Limestone* of Tunstall and Humbleton Hill, Ryhope, Dalton-le-Dale, Hylton Castle, Clack's Heugh, etc.; and *Concretionary* or *Pseudo-brecciated Limestone* of Galley's Gill, Tron Rocks, coast between Ryhope and Hawthorne Hive, etc. Thickness—150?	*Small-grained Dolomite* of Lound Hill, Vale of Went, Brodsworth, Cusworth, Levit Hagg, Warmsworth, Roche Abbey, etc. Thickness—200 ft.
Lower Limestone.	*Limestone* of Pallion, Millfield, Pensher, Newbottle, Houghton-le-Spring, Moorsley, Pittington, Sherburn, Ferry Hill, Summerhouse, etc. Thickness—200 ft.	*Limestone* of Pontefract, Emsall, Wentbridge, Hampole, Brodsworth, Barnsbro' Cliff, Cadeby, Conisborough, etc. Thickness—120 ft.
Marl Slate.	Marl Slate of Clack's Heugh, Down Hill, Midderidge, Ferry Hill, etc. Thickness—10 ft.	
Lower Red Sandstone.	Incoherent and Red Sandstone of Clack's Heugh, Hylton Castle, Tynemouth Cliff, Downs' Quarry, Sherburn, etc. Thickness—100 ft.	Red, Yellow, and Variegated Sandstones of Pontefract, Hickleton, Wentbridge, Cadeby, etc. Thickness—100 ft.?
	Total thickness—760 ft.	*Total thickness*—590 ft.

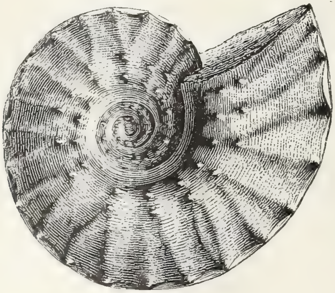

Fig. 1.

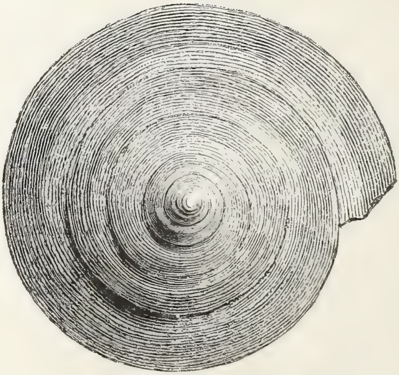

Fig. 2.

1. AMMONITES VARIANS. 2. PLEUROTOMARIA PERSPECTIVA.

From the Grey Chalk of Dover.

[In the Folkestone Museum : Mackie Collection.]

S. J. Mackie del.

Tabular View of the Permian Strata of the North-West of England, as seen at Shawk, west of Carlisle, Westhouse, south of Kirkby Lonsdale, and Manchester, in the Descending Order.

	Shawk.	Westhouse.	Manchester.
	Feet.	Feet.	Feet.
1.*Laminated and fine-grained red sandstones	300	not seen.	not seen.
2. Red and variegated marls, containing sometimes, but not always, beds of limestone and gypsum, with fossil shells of the genera *Schizodus, Bakevellia,* etc.	150	traces of them seen.	300
3. Conglomerate	4	300	50
4. Lower New Red Sandstone, generally soft and incoherent	7	500	500
5. Red shaly clays	not seen.	250	not seen.
6. Astley pebble-beds, containing common coal plants, but quite unconformable to the upper coal-measures, termed by me Lower Permian	not seen.	not seen.	60

NOTES AND QUERIES.

Correlation of the Grey Chalk and Upper Greensand.—There is no more important point to be settled in the physical geology of the Cretaceous formation than the determination of corresponding horizons over different geographical areas of the Grey Chalk and Upper Greensand. The stratigraphical range of fossils in each, and the collating of those of both deposits from different localities with each other, would work out some important results. It is too much, perhaps, to ask our readers who live in chalk or greensand districts to send in lists of all the fossils they have collected,—although we should be very thankful indeed for such lists; but by drawing attention to two of the characteristic fossils of the Grey Chalk which we have figured in Plate X., we shall possibly receive through the kindess of our many friends, notices of the localities and strata in which they know them to occur. To note the beds and the places in which collectors have found these two shells will cost them a mere fraction of trouble, while the result will be an indication of considerable value in determining the conditions of deposits, and the possible synchrony of those two great deposits, and will help to bring isolated Cretaceous deposits into place in the chronological series.—S. J. Mackie.

Subterranean Trees at Purfleet.—Here (Purfleet) was a ferry over the Thames into Kent. That river made a breach and inundation at West Thurrock in the year 1680; at which time subterranean trees were washed out in as great numbers, and of the same kind of wood, as those found in Dagenham and Havering levels in 1707. (See Phil. Tr. No. 335, p. 478; and Abridg. by H. Jones, vol. iv. part ii. p. 219; and Morant's Essex, vol. i.)

Fulgurite near Macclesfield.—Besides the Mammalian bones from this district, Mr. Sainter has sent us various other fossils he has collected there. Amongst them is a small part of a Fulgurite "found in the drift on the west side of the town, last December." "It was traced," Mr. Smith says, "thirty feet below the surface, and terminated in a layer or bed of soft marl. It passed through a bed of fine sand, almost perpendicularly. The diameter of the tube near the surface was nearly three-quarters of an inch. It gradually diminished in width in its descent, and towards its termination split into a number of finer tubes ending in points. Some parts of the tube possessed bead-like vitrifications on the inner surface, and it was contorted." Those who have read Dr. Gibb's interesting summary of this subject in Vol. II. p. 195, will be pleased to see recorded this additional example.—Ed. Geol.

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* The first four strata of the above series, Professor Harkness, F.R.S., in a fine natural section seen at Hilton Beck, north of Brough, estimates to be of 3000 feet in thickness.—*Quarterly Journal of the Geological Society* for August, 1862.

Pilot Knob, in Missouri, is a conical mound of a sugar-loaf shape, 550 feet in height, and covering 500 acres. According to estimate, it contains no less than 220,000,000 tons of iron ore, having 65 per cent. of pure metal in it.

Native Copper.—A mass nearly pure has recently been discovered in the Mesnard district, Michigan. It is 40 feet in length by 4 broad, and as many high ; its weight is about 50 tons. Another great mass of copper has been met with in the same district, 15 feet 7 inches long, 3 feet 7 inches to 5 feet wide, and 18 inches thick ; giving 87 cubic feet, or a weight of 23 tons. A small portion only of the mass, covered by moss and underbush, was above the surface when discovered. On removing the soil, pieces of charcoal, some stone hammers, gave traces of old Indian workings ; the eastern end of the mass showing plainly that a portion had been broken off.

REVIEWS.

'*The Antiquity of Man:' an Examination of Sir Charles Lyell's recent Work.* By S. R. Pattison, F.G.S. London: Reeve and Co.

"The moral and spiritual teachings of the Bible would remain untouched, though it were proved that its histories must be restricted to one human period alone amongst several. But the supposition that there have been many such periods is contrary to our first impressions. The burthen of proof lies therefore on those who propose it." Thus opens Mr. Pattison's pamphlet, with a dictum no one would be willing to gainsay. This condition of proving what is contrary to popular, cherished opinion has been accepted by Sir Charles Lyell, who has adapted the evidence of the Antiquity of Man in his recent work to the support of one school of zoological theorists rather than to the deliverance to the public of the actual geological evidence as it is, or as it is viewed by at least very eminent sections of geologists and zoologists. To adapt all the evidence that came to his hand to his own purposes, and to the support of his own views, is no more than we should have expected of Sir Charles, who, in all his published works, has adopted this practice. Nor have we much to say against him on this score. If he belong to a party,—and he is always a partisan,—there is no objection to his doing all he can to advance their views ; but a partisan draws down on himself a great deal of bitter antagonism. Perhaps Sir Charles has experienced more of this already than he anticipated. With personalities we have nothing to do in our reviews ; our view goes to the science, not the man. Mr. Pattison objects to the

Lyellian doctrines, and puts forth his own opposing views in a concise, clever pamphlet of twenty pages; and he assails his opponent at any rate with righteous weapons. Mr. Pattison begins by putting Archbishop Usher and the biblical chronologers against Sir Charles's arguments that man has existed certainly 7000 years, probably twice as long, possibly four times as long. Are these deductions warranted by the evidence? is Mr. Pattison's question, which he proceeds forthwith to answer. To the Lyellian arguments on the first point, that western Europe has been inhabited by man for more than 7000 years, Mr. Pattison quotes Sir Charles of old against Sir Charles of late, not always quite correctly to our mind, but generally fairly. His grand quotation attack—that Lyell formerly quoted from Gerard, the historian of the Valley of the Somme, that in the "lowest tier of that moss was found a boat loaded with bricks"—will not hold good in scientific argument. If the peat or the deposit on which a heavy-laden boat sank down were soft, there is no doubt that the boat would "swaddle" down to the very bottom of the soft stratum, be it mud or peat, until it rested on a hard bottom; and a boat sunk twenty years ago might even be dug out to-day from the lowest portion of a peat bog, or the oozy bed of a river. Mr. Pattison's reasoning on the age of the Danish peat, that the separate deposits of pine, oak, and beech were due to the successive surrendering to decay at distinct periods of woods of different hardness, is much more ingenious, and must more or less subject what has been hitherto written and said on the subject to further scrutiny. It is, however, this disregard of this element of the sinking of heavy bodies through soft and readily-yielding deposits that has given rise to the generally incorrect idea of "7000 years being sufficient for the growth of all the peat on the face of the globe." Thick beds of peat may be formed in such a space of time, but we must not thence conclude that all peat-beds have been formed in an equally short space of time. Mr. Pattison's remarks on cave-deposits, gravel, and brick-earth, are also very good, although we do not concur in his remarks on the absence of evidence of any changes in the shores of the British Channel within the Historic period, which would give a measure for the antiquity of the later post-Tertiary deposits on both sides of that "narrow sea." The legends of Cornwall and Brittany must not be lost sight of, as indicating great and very ancient changes, so remote, that the legends read now to us like myths. Neither must the traces of ancient forests, which the fishermen's trawls and the dredge bring up, be altogether forgotten or ignored. A British Association grant to an active explorer would bring out much singular information on this point.

"There is nothing," Mr. Pattison concludes, "in the ascertained facts of geology, nothing in the exhaustive volume before us (Lyell's), to forbid the hypothesis, that at some period after the final retreat of the glaciers man found his way into these regions as a wandering hunter, probably from a distant geographical centre; that he resorted to these parts at intervals during several thousand years; that its pebble-beds afforded him implements, and its grassy plains abundant game; that in the intervals of his occupation the earth was rent, in connection with volcanic action dying out in the Eifel and Auvergne, floods occurred, the loose materials of the surface were washed into crevices or spread out in heaps; that many of the great mammals became extinct, some so lately as the mammoth, whose flesh was found in ice at the mouth of the Neva. For upwards of 4000 years, all things were in course of becoming what they now are; and what they so became, they have remained, save surface accumulations and minor changes, for the last 2000 years and upwards. For aught that geology or palæontology has yet to show, this is as valid an explanation of the phenomena as that which, under the semblance of indefiniteness, is carefully definite for a long time before Adam. If it is physically and philosophically possible to intercalate all the epochs of man, shown in the monuments of the globe itself, within the compass of the years assigned to the same occurrences by the received interpretation of Scripture, my task is done. I claim the verdict of 'Not proven' on the issue raised."

We do not side with Mr. Pattison's views, but we are willing to admit that no one of his school has put forward on any occasion more sensible or more critical objections than he has done in this unpretentious brochure.

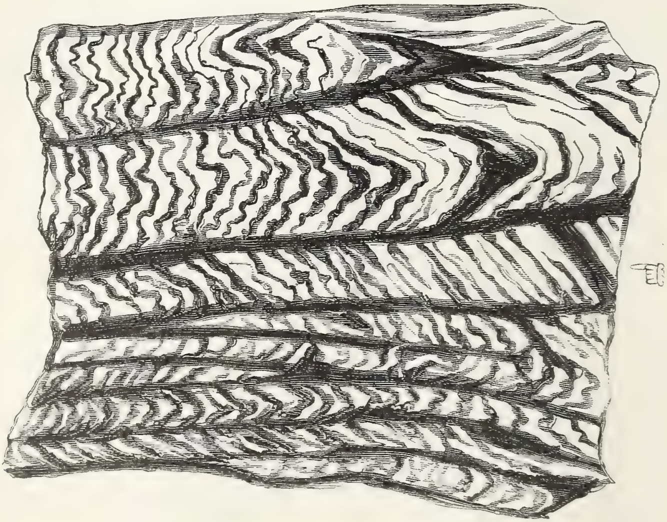
Descriptions of two New Genera (Trypanostoma and Goniobasis), and of New Species of Unionidæ and Melanidæ. By Dr. Isaac Lea.

The enormous number of species in the genus Melania has made it desirable, Dr. Lea thinks, to eliminate as many as possible by founding new genera. The genus now proposed by him, Trypanostoma, will include all the Melaniæ with an auger-shaped aperture. For those having usually a slight thickening of the upper part of the columella and no callus below, and which are also without the notch of Haldemann's genus Lithasia, to which they are nearly allied, although subangular at the base, Dr. Lea proposes the generic name of Goniobasis.

M'Leod's Wall-Map, England and Wales: No. 3, Geological. By Edw. Weller, Esq., F.G.S. London: Longmans.

The sheet-maps of the Geological Survey, with their full details acquired by actual investigation in the field by competent geologists, and the general map produced by Professor Ramsay, the Local Director of the Survey, from the official materials of his department, leave no excuse for a bad geological map of England and Wales, nor much merit for producing a good one. Nothwithstanding these facilities, it is usual to find publishers producing geological, or rather ungeological, maps of the vilest character,—inaccurate in delineation, erroneous in geological subdivisions, and coloured fortuitously by some mere print-dauber. The wall-map before us, sent for our criticism by Messrs. Longman, however, deserves every praise. It is of convenient size—4 ft. 3 in. by 3 ft. 3 in.—small enough to hang on any ordinary school-wall or library without inconvenience, large enough for the particulars to be seen at a considerable distance; it is accurately delineated, and nicely coloured. The details inserted are quite sufficient for ordinary purposes, as is also the stratigraphical section of subdivisions, which acts as a key to the colouring. Altogether we can conscientiously recommend it as the best map of the kind extant. No other for scholastic purposes can be compared with it at all. In the copy we have received, two or three patches are omitted to be coloured, an oversight which should be seen to by the editor or publisher, as such omissions, which occur through the stupidity and carelessness of the colourers, are detrimental to the high character the map ought to possess with the public.

PLATE XI.



RIPPLE-DRIFT STRUCTURE IN MICA-SCHIST.

From a Specimen collected between Arroquhar and Tarbet. (Nat. size.)

[In the Collection of H. C. Sorby, Esq., F.R.S.]

S. J. Mackie del.

THE GEOLOGIST.

JUNE 1863.

RIPPLE-DRIFT IN MICA-SCHIST.

By the Editor.

Of all English geologists, Mr. Sorby has been at once the most indefatigable and the most successful in the study of the microscopic structure and metamorphic conditions of rocks. The brief abstract furnished us by the Geological Society, which we print at p. 231, gives but little idea of the importance of the paper Mr. Sorby read last month. It gives, it is true, the pith of the subject, but so short and inexplanatory a paragraph is not likely to attract such attention as the paper deserves. Those who have the pleasure of Mr. Sorby's acquaintance know how persistently he works at anything puzzling which comes in his way. He never leaves it until he has got to the solution of the riddle. It happened some time ago, when in Germany, at the meeting of *savants* at Speyer, on which occasion he transmitted an account of the proceedings, with some notes on meteorites and sponges (see Vol. IV. p. 501), that Professor Blum presented him with a specimen of the singular conglomerate known as the "nagel-flue." This conglomerate, which occurs in some places in Switzerland, consists of hard limestone pebbles, the ends of some being impressed into the substance of others,—a condition hitherto inexplicable, although Blum, Von Dechen, Escher von der Linth, Nöggerath, Daubrée, and others have essayed opinions and suggestions, some of them attributing the impressions to merely mechanical, others to purely chemical action. In working out this investigation, Mr. Sorby eliminated evidence of a new phase in the correlation of physical forces; and in an able and valuable paper recently read before the Royal Society, showed the evidence of a *direct* correlation between mechanical and chemical force. This new phase of the direct correlation of those forces is destined undoubtedly to have a wide influence on that branch of geological research that attempts to explain those various phenomena which are the results of rock-masses having been subjected for long periods to pressure, and during which such mechanical force must have modified materially those chemical changes which were dependent on the slow action of weak affinities.

This subject is, however, only incidental to our present topic; but just as the study of these curious "nagel-flue" pebbles has brought us the knowledge of a new phase in the correlation of forces, so the knowledge of the direct correlation of mechanical and chemical force will soon manifest its influence in increased knowledge of metamorphic conditions. Already we have the germ before us, in Mr. Sorby's observations on the presence of ripple-drift in mica-schist; for the presence of that structure shows former sedimentary origin.

While standing under the shelter of some rocks during a shower of rain, Mr. Sorby saw, on their wetted surfaces, some markings which struck him as being the more or less contorted lines of that peculiar kind of deposition which, in his former accounts of the intimate structure of rocks, he has called by that term. "When ripple-marks are found," he says in a communication to ourselves, "whilst material is being deposited, a structure is generated which I have called 'ripple-drift' in various papers published on the subject. It might very well happen that no fracture of this could show any 'ripple-marking,' properly so called, but yet it is so peculiar and has so many characteristics, that one could not confound it with any structure produced by other means. If we were to find what looked like ripple-marking in mica-schist, we could not be sure that they were not some of the mere mechanical bendings so common in that rock, and hence we ought not to base any important conclusion on their occurrence. However, the structure of ripple-drift is so different from anything that could be produced by any other means, that its occurrence in mica-schist must be looked upon as a most convincing proof of the sedimentary origin of that rock. In some cases the micaceous schist of the Highlands of Scotland show this structure to great advantage, and there can be little or no doubt of its nature; but in other cases the very great disturbances which have produced so many contortions in the rock, have so modified the arrangement that it is only by carefully following all the transitions from simple to complicated that the true nature of some of the contorted bands of ripple-drift can be understood. In no other way can we explain the various curious structures that are met with in some localities, as, for instance, the neighbourhood of Arroquhar, whence I have a number of specimens prepared so as to show the structure in a very striking manner. The value of the fact of the occurrence of the ripple-drift consists in its proving so very conclusively that the schists were originally deposited in the same manner as ordinary sedimentary rocks, under the influence of gentle currents. Moreover, in studying the microscopical structure of various mica-schists, one may see some of the original grains of sand, although since somewhat altered, and may clearly perceive that the present characters of the rock have been produced by a general crystallization of the various constituents, so as to give rise to what is known as a metamorphic rock. In one thin microscopical section proofs were exhibited of all the leading facts of metamorphism. We had the evidence of deposition from a gentle current of water, of subsequent compression, and of the alteration of the whole into a highly crystalline rock."

The specimen of ripple-drift in mica-schist which we figure in Plate XI. is from between Arroquhar and Tarbet, and our engraving is from a drawing which Mr. Sorby has kindly sent us. "It was," he says, "somewhat difficult to convey the true character of the rock, but will be more easy on a wood-block, for it is really a white pattern on a black ground. You must bear in mind that the small black stratula pass completely into the larger bands. I mean the, stratula in the line *a*, *b*, *c* are continuous with *a a*, *b b*, *c c*. (See Fig. 1.) Also, these dark stratula become thicker near the junction, or, as is really the case, the white bands of quartz, which were originally sandy, thin out at the ends. Of course you understand that, in the case drawn, the whole has been much disturbed and greatly contorted, the only part at all in its original state being the right-hand side of the central band, where I have drawn a hand pointing." (See Plate XI.)

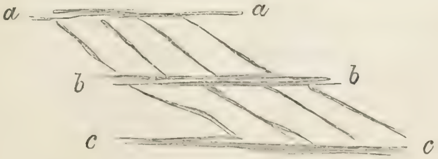


Fig. 1.—Stratula passing into larger bands.

Without wishing at present to go into any discussion of the subject of central heat, we can but rejoice at the acquirement of this evidence of the former sedimentary origin of this highly metamorphosed rock; and we sincerely hope that it will not be long before we have more proofs of the like nature. Heat *may* have had much influence in effecting metamorphic changes, but we think it far more likely that water, mechanical pressure, and chemical action have been the principal workers in metamorphic action. The curious sections of encrinital limestone which Mr. Sorby exhibited at the last Royal Society soirée, showing how mechanical pressure and chemical action had caused the solution or removal of the material of the encrinital joints on the one side, while on the other deposits of other materials had taken place, gives indication how such processes could affect rock-masses on a large scale; and while geologists are demanding heat to reduce to a pasty condition our metamorphic rocks, why, we would ask, might not such mechanical and solvent actions, by removing obstructions to motion on the one hand and permitting a deposit of material on the other, be a slow but sure way of bringing the integral particles of rocks into crystalline forms or into parallelism with each other, so that every form of metamorphism, and even slaty cleavage, might be thence produced?

By natural and *existing* phenomena we should attempt, in the first place, to elucidate geological conditions. Cold water is much more abundant than hot; it does a great deal. We have no real knowledge now of any deep-seated dry heat-action going on. We may imagine such; but I much doubt if the mechanical, chemical, and crystalline forces, combined with the solvent power of water, are not quite sufficient to produce very many of those effects we have been in the habit of assigning to the internal fires.

ON THE OLDER PARIAN FORMATION IN TRINIDAD.

By R. Lechmere Guppy.

In the Report on the Geology of Trinidad the Government geologists described a series of sandstones and shales extending across the island from east to west, and occupying an extent of about 97 square miles. The distribution of the formation, which has been named the "Older Parian," is in the manner of an irregular band of from 1 to 4 miles in breadth, traversing the island in an easterly direction from the Gulf of Paria at Pointe à Pierre. This band terminates rather abruptly before reaching the east coast, but the formation reappears here and there near the south coast along a line parallel to the main band.* The formation is only exposed for a short distance on the shores of the Gulf of Paria; but it has been found to cover a large area, and to be extensively developed on the continent of South America. The fossils found by the geologists in Trinidad seem to have been few, and for the most part indeterminable. They however obtained fossils from the same formation at Cumana, in Venezuela; and these remains led to the belief that the Older Parian was probably of Neocomian age. During a short visit to Pointe à Pierre I obtained several fossils, which have enabled me to make the observations detailed in the present paper.

The section given by the Government geologists of the Older Parian deposits at Pointe à Pierre† is taken on the south side of the point, which I have not had an opportunity of examining carefully. The geologists do not seem to be able to give much attention to that portion of the deposits which is exposed on the north side of the point, and I hope that the present paper, in so far at least as it relates to the fossils, may in some measure supply the deficiency.

The extreme point of the cliff at Pointe à Pierre is formed of a hard ferruginous sandstone, which is somewhat brittle and coarse in its structure, and contains no fossils. The dip is from 40° to 45° south. The beach north of the point is passable at low water, and consists of pieces of rocks more or less rounded, which have fallen from the cliffs above. Going north along this beach, we find alternations of sandstone of variable quality, with shales of a black colour and thin unconsolidated layers of very fine sandy matter, some of which are black and some nearly white. It is only, however, at the north end of the beach that I have been able to detect organic remains. The most conspicuous of these is a *Trigonia*, considered to be the same species as that found at Bogotá, and named by D'Orbigny *T. subcrenulata.*‡ Of this fossil, I have found one entire specimen and several disunited valves.

Mr. Etheridge notices the entire absence of Cephalopoda in the collection made by the geologists when there, stating that the want of such fossils prevented a comparison with the strata at Bogotá and in other parts of South America.§ I have obtained a specimen of *Belemnites* from Pointe à Pierre, so very imperfect and worn however, that it is difficult to ascertain to what section of that genus of Cephalopoda it belongs. If, however, it belongs, as is perhaps probable, to Brown's section Acœli, it furnishes additional evidence of the correctness of Mr. Etheridge's determination of the age of the strata exhibited at Pointe à Pierre as Neocomian. The presence of the Belemnite is at once a proof of the Mesozoic age of the Older Parian group; and, as Belemnites are not found above the Chalk, we must consider the Pointe à Pierre deposits as undoubtedly equal to or older than the true chalk.

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* Report on the Geology of Trinidad, p. 34.

† Ibid., sheet no. 2, fig. 2.

‡ Ibid., p. 163.

§ Ibid. See also Wall, "On the Geology of Venezuela and Trinidad," Quart. Journ. Geol. Soc. vol. xvi. p. 460 *et seq.*

Numerous fragments of an oyster somewhat like *Ostrea carinata*, a fossil of the Lower Greensand, are found with the Trigonia. I have not however been able to obtain a perfect specimen. At the same locality I have found oysters referable, perhaps, to two other species. One of these is a good deal like the recent *Ostrea edulis*, and one of my specimens shows the markings of the hinge cartilage very distinctly. I have also found a single valve of a deeply sulcated bivalve, which may be an Avicula, but which presents some resemblance to a fossil described by Von Buch as a Pecten under the name of *Pecten alatus*.* My specimen, however, has fewer sulcations than the shell described by Von Buch, and the absence of wings makes the determination somewhat uncertain. It is possible, however, that the shell in question may be a young specimen of *P. alatus*.

Gasteropoda are also represented among the fossils from Pointe à Pierre, but the specimens are generally so imperfect as to render the determination of their relationships difficult. A cast in my possession, upwards of 2 inches in length from the apex to the peristome, seems to be of a naticoid type. Another cast, which has some shelly matter remaining on it, is very like a cast figured by Von Buch as a Rostellaria, and may belong to the same species.†

A single valve, embedded in a calcareous nodule, from Pointe à Pierre, appears to have belonged to a Plagiostoma, while a massive gibbous valve about 2½ inches in length, has some of the characters of a Cytherea; but that genus is not common in rocks of such ancient date. Amongst the fossils collected by me, are several other fragments of Mollusca, which appear to be indeterminable. Still, though there is much doubt respecting a great part of the fossils yet collected from these deposits in Trinidad, enough has been discovered respecting them to confer a character of greater certainty on the presumption of the age of the Older Parian deposits in this island than has been previously attained to.

All the fossils I have been able to obtain from Pointe à Pierre have been from the beach; consequently, they are usually much worn, and it is hardly possible to ascertain from what portion of the group they have been derived. The Trigonia and the oysters are tolerably well preserved, as far as their structure goes; but the shells of the Gasteropoda have nearly disappeared. The thick and massive character of the shells is worth notice, and it prevails alike in all the specimens in which the test is preserved.

From what I have said in this paper, it will be seen that the palæontological evidence is in favour of Mr. Etheridge's view‡ of the age of the deposits termed "Older Parian" by the Government geologists. Until, however, more fossils can be obtained, and their position in the series better determined, it will be as well to leave the precise age of the formation an open question, and to remain satisfied for the present with having arrived at the conclusion that the Older Parian deposits in Trinidad, and the rocks of similar age in South America, cannot be newer than the Gault.

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* Von Buch, 'Pétrifactions recuellies par Humboldt,' pl. i. figs. 1, 2, 3, 4.

† Von Buch, 'Pétrifications,' pl. ii. fig. 27.

‡ Report on the Geology of Trinidad, p. 163.

List of fossils found by the Government geologists in the Older Parian at Cumana:—*Pteroceras*, *Cerithium*, *Turritella*, *Trigonia subcrenulata*, D'Orb., *Astrea Couloni*, *Arca*, *Cardium*, *Echinus*.

Those found in Trinidad since the survey, and alluded to in the above paper, but not included in the foregoing list:—*Belemnites*, *Rostellaria ?*,[*] *Natica ?*, *Cytherea ?*, *Plagiostoma ?*, *Pecten alatus ?*,[†] *Ostrea*, 2 sp.

DESCRIPTION OF A LAND SURFACE UNDERNEATH THE DRIFT ON THE COAST OF SUFFOLK; OBSERVED IN 1859.

By S. R. Pattison, Esq., F.G.S.

The low cliffs stretching from Gorleston, south of Yarmouth, towards Lowestoft, are mainly composed of boulder drift, and are well described by the late Mr. Trimmer in the Quarterly Journal of the Geological Society for 1857. As an independent confirmation of his observations on the intercalation of the whole boulder-clay double series, between the fluvio-marine and forest bed beneath, and the local marls and marsh and estuary beds occasionally above, I send the following note, made without having had the benefit of Mr. Trimmer's paper.

On the beach under Corton the section is as follows:—

	Feet.
Mould	2
Disturbed ferruginous sand	10
Alternations of gravel and sand, frequently interchanging. Gravel well rounded and small. Large masses of dark clay entangled in the gravel with lumps of chalk. Small rolled pebbles of chalk, boulders of slate rock, coal-measures, greenstone, red sandstone, oolites (very abundant), having an average depth of	30
Clean brown sand, with occasional very small pebbles	40
An irregular bed of peat, surface and contents of marshes, compressed rush-like plants matted together, and much mineralized with sulphate of iron	2
An irregular surface below the bog, covered with roots and lower portions of stems of ferns (Pteris ?) *in situ*, in a dirt-bed; occasionally large trees	5
Dark clay, with a greenish tinge, underlying the heath-like de-	

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[*] Perhaps the Pteroceras of the Geological Survey.

[†] Possibly an Avicula.

posit above, abounding in Cyclas, opercula of Bithynia ?, and traces of other Planorbis-like shells, very small flint-pebbles and occasional peaty layers	4
Total	93

CORRESPONDENCE.

Age of Prehistoric Man.

Sir,—In Professor King's valuable paper on the "Glacial and Post-glacial Deposits," in the 'Geologist' of last month, the learned author of this most interesting paper says: "The genus Homo belongs to both the glacial and post-glacial period; it was represented as early as the close of the subaqueous epoch, or the beginning of the second subaerial division of the glacial period, by a low form or extinct species, a view strongly countenanced by the Neanderthal skeleton, as well as the rudely chipped flint-implements occurring in the elephant-gravels of Amiens, Hoxne, and other places. Probably a higher type existed at the same time, as indicated by the skulls found in the Engis caves near Liége."

I must venture to express an opinion that the theory which assigns the Engis and Neanderthal skeletons to any particular division of the glacial period is scarcely warranted by the facts before us. Without wishing to throw any doubt on the demonstrated antiquity of the Engis skull, of which the age is fully proven, in the words of Huxley, to carry us back to the "further side of the vague biological limit which separates the present geological epoch from that which immediately preceded it," I would wish to ask what is the geological or palæontological proof of the following propositions:—

1. That the Neanderthal skeleton was probably coæval with the remains from the Liége caverns.

2. That it was coæval with the "high-level" flint-implement gravels of the Somme valley or of Hoxne.

3. That the species of man to which it belonged is extinct, *i. e.* different from a race having the same general cranial character as some existing Australians.

Sir Charles Lyell, in his 'Antiquity of Man,' remarks justly that the Neanderthal skull has given rise to surprise "because, having no such decided claims to antiquity [as the skull from Engis], it departs so widely from the normal standard of humanity;" and concludes his remarks on the evidences thus: "If we conceive the [Neanderthal] cranium to be very ancient, it exemplifies a less advanced stage of progressive development and improvement. If it be a comparatively modern race, owing its peculiarities of conformation to degeneracy, it is an illustration of what the botanists have called 'atavism,' or the tendency of varieties to revert to an ancestral type, which type, in proportion to its antiquity, would be of lower grade."

The fact cannot be too prominently brought before us, and must again be borne in mind, that no flint-implements or any other works of art were found in the Neanderthal cave, and that the tusk of bear which was found at the same level as the human skeleton has not been identified with any recent or extinct species; likewise that the depth in the mud or loam (five feet thick in all) in which the skeleton was found has not been recorded.

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* Page 89. † Page 92.

A priori probability would lead biologists to infer that pithecoid man first existed on this planet; but in the present stage of the controversy it is, in my opinion, most hazardous to frame a table on the mere probability of a fact.

Yours very truly,
C. Carter Blake.

The Portland Fissures with Human Remains.

Sir,—Will you allow me to make some remarks on the letter of Mr. Jicks in the 'Geologist' of this month, in which he seems to doubt the correctness of the facts which I mentioned in my letter in the 'Geologist' of last month, that the remains of man and of extinct mammalia have been found mingled together in fissures of the rock of Portland Island, which fissures do not extend to the surface of the rock?

The whole question depends, of course, on the nature of evidence which I produced of the truth of these facts. My first evidence was the testimony of the writer of an article in 'Willis's Current Notes' for the month of August, 1852, who had himself visited Captain Manning, at Portland Castle. He states expressly—on the authority, of course, of Captain Manning—that on several of the ledges, in the fissures of the Portland rock, which do not extend to the surface-soil by 5 or 10 feet, a number of bones of all kinds of animals have been found, including those of the human species. The truth of this statement has been in the fullest manner confirmed to me by Captain Manning himself, who showed me, at the Castle, his collection of bones, which were those of men, the elk, the reindeer, the elephant, etc. He said that the fissures in which they were found did not extend to the surface of the rock. He also said, what is stated in 'Willis's Current Notes,' that Dr. Buckland, who visited him at the Castle, being first attracted to the island by the discovery of a fossil boar's head, having doubts as to the place where the bones were found, accompanied him to the fissure, where a lad was let down, who brought up more of the bones in his presence.

The next evidence which I produced was an article in the 'Times' of the 1st of last January, relating to the fortifications recently built in Portland Island. The article states that in these fissures, "commencing about 20 feet below the surface of the ground, human bones have been found with those of wild boars, and horns of reindeer, not fossilized, but with all their osseous structure as perfect as if they were not fifty years old." The high preservation of these bones proves that they must have remained entirely excluded from the air from the time that they entered the limestone formation to the period of their discovery.

Can the facts which I have mentioned be disproved,—that human and mammalian bones have been found in fissures of the Portland rock, which do not extend to the surface of the rock? If these facts are true, which may be easily ascertained by any person's visiting the island, they prove, beyond a doubt, that the human and mammalian bones must have been embedded in the rock *before* its consolidation, and consequently, that the men and animals to whom they belonged must have inhabited some other dry land, probably now destroyed.

Again, what can explain the association in the fissures of the bones of the reindeer, an arctic animal, with those of a tropical animal, the elephant, but that they were brought to the same spot from arctic and tropical regions by the catastrophe which buried them in the Oolite formation, which was probably a universal deluge? For arctic and tropical animals never could have lived together in the same climate. The association of the remains of arctic and tropical animals has also been observed in other places. In a cavern at Brixham, near Torquay, in a mass of loam or diluvium, 15 feet in thickness, have been found the remains of the mammoth, the extinct rhinoceros, cave-lion, cave-bear, cave-hyæna, *reindeer,* a species of horse, of ox, and several Rodentia, besides other bones not yet determined. Speaking of similar geological facts, M. Cuvier remarks, that "the associated remains of the glutton and the hyæna, the rhinoceros and the reindeer, found in the same caverns, as we observe at Gaylenreuth and Brengues; the bison and the elephant, in the same diluvium, as we find in the valley of the Arno,—certainly reveal either a state of the earth very different from what we now witness, or imply in these animals a temperament opposite to what their kindred species now display." The remains of the lion or tiger, the rhinoceros, the hyæna, elephant, elk and *reindeer,* and other animals, have also been found in the quarries of Kostritz, in Upper Saxony.

As the remains of arctic and tropical animals, whether found in caverns or on the surface of the earth, are almost always embedded in loam or diluvium, which, according to Dr. Buckland, was deposited by a general deluge, it is far more reasonable to suppose that, as I have already intimated, they were transported to their present situations by a general deluge than that animals belonging now to such opposite climates should have formerly lived together in the same climate.

I am, Sir, your obedient servant,
Thos. D. Allen.

Rectory, North Cerney, Cirencester, April 21, 1863.

[How could there be a fissure before the rock was consolidated? and are we to believe that the elephants, etc., and men too, in those days, lived at the bottom of the sea, as they must be supposed to have done if we accept Mr. Allen's theory of the Portland ossiferous fissures occurring before the consolidation of the Portland Oolitic beds? Fissures of shrinkage may not, sometimes do not, extend to the top of a vertical section, any more than sand-pipes in a chalk-pit, which we know to be filled from above. The accompanying diagrams will show how a fissure may extend to the surface, and yet not be visible, in the face of a quarry or cliff occurs at Portland, and no doubt something of this kind has mystified Mr. Allen and his friends.—Ed. Geol.]

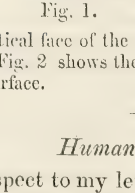

Fig. 1.

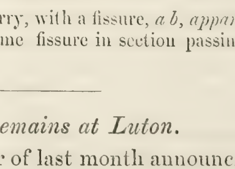

Fig. 2.

Fig. 1 shows the vertical face of the quarry, with a fissure, *a b, apparently* covered by the solid beds 1, 2. Fig. 2 shows the same fissure in section passing diagonally through the beds to the surface.

Human Remains at Luton.

Sir,—With respect to my letter of last month announcing the discovery of two human skeletons in the brick-earth at Luton, subsequent careful examination has induced me to believe that they were not in the undisturbed brick-earth, but in the lower part of the bed which lies immediately upon it, consisting of washed brick-earth, the run of the hill. In this bed, which at this particular point is between 7 and 8 feet in thickness and deepens towards the N.E., there is a great difference between its upper and lower portions, for about 4 feet from the upper surface it contains a very large quantity of flints, below that they are less frequent, and disappear as you approach the true brick-earth. At first sight, there seems to be but little or no difference between the lower part of the rain-wash bed and the true brick-earth. Also, from the men that removed the soil immediately over the skeletons, I found that there was distinct evidence that it had been disturbed, for part of the upper portion of the bed was found mingled with the lower; that and the fact that the stone was between the skeletons, close to the skulls, would tend to show that they had been buried there, though perhaps at some remote period.

I remain, yours sincerely,
H. F. Rivers.

Sidney Villa, Luton, Chatham, May 25, 1863.

Holoptychius and Glyptolepis.

Dear Sir,—Will you allow me space for a few remarks on communications which have recently appeared in your pages, and which have been suggested at least by articles of mine?

And first, as to the restoration of Pteraspis, I intended that in my second diagram the posterior portion of the test should be marked off by a dotted or broken line. I was uncertain as to the exact position of the spine, and did not therefore venture to restore that portion, although specimens of it separated from the test were in my possession. Mr. Powrie's beautiful specimen clearly indicates the character and position of the spine. But on looking at his figure, it will be seen that it confirms the remark which I made, and which I considered the chief point brought forward by me, even that our Scottish specimens do not show any separation between the cornua and the test, but that the terminal edge on either side of the spine is continuous. I willingly admit that a shade of doubt rests on my first diagram; but I had virtually stated the ground of that myself, and I consider that diagram as of value chiefly in exhibiting the long-snouted form which the shield of Pteraspis sometimes assumes, perhaps indicating specific difference. I put forward my third diagram as entirely conjectural, and, along with my friend Mr. Powrie, must turn to the rocks, in the hope of finding some of those long-entombed relics which will throw light on the matter.

And then, as to the case which has been so much debated in your columns,—Holoptychius *v.* Glyptolepis,—I knew from Mr. Powrie's own article in the Quarterly Journal of the Geological Society that Glyptolepis had been noticed in the sandstone of Dura Den, and I simply wished to describe a slab in our local museum from that locality. I did not know what correspondence there might be privately between those who were interested in the matter. I am glad, however, that the attention of Mr. Davies has been called to it, and that he has communicated to your readers the results of his keen discrimination. On the specimen of *Holoptychius Andersoni*, to which I have access, there are several scales towards the posterior part of the body, which display what Mr. Powrie calls so picturesquely "the crescent of points;" but from what was said in the 'Decade' by so correct an observer as the author of it, I was disposed to think that these might be scattered scales of Glyptolepis lying there. I have looked at them again, and now believe them to be in their original position, or at least slightly displaced. I am afraid that Holoptychius, unless the other points of difference hold, will have to go down before the kindred Glyptolepis; but without determining the issue, I have simply sought to place on record what I had observed in the slab dug some years ago from Dura Den. *Quantum valeat.* Yours truly,

HUGH MITCHELL.

Craig, May 6th, 1863.

The Lincolnshire Flats.

SIR,—A letter, headed "The Antiquity of Man," which appeared in the 'Times' newspaper of April 16, 1863, from Mr. J. A. Clarke, of Long Sutton, will, it is to be hoped, direct the attention of geologists to the marsh and fen countries in the east of England. As he happily expresses himself, "these districts interlace archæology with geology;" and in confirmation of this, I would offer to you a few remarks upon one small portion of the marsh, on the east coast of Lincolnshire: that portion lies in the parishes of Orby, Addlethorpe, Ingoldmells, Hoggsthorpe, Burgh, and Thorpe. I speak more particularly of the first three parishes, any few observations that I have myself made referring to them, and what I know of the others, being more from hearsay.

I was a frequent visitor to the seacoast of Lincolnshire in years past, and my attention was called to certain nodules of burnt clay, called by the country people "hand-bricks," because they almost all bear the impression of the human hand, as though they had been grasped by it. Many fanciful ideas have been attached to their origin and use; but very little examination is sufficient to determine that they are the refuse of some manufacture of pottery, and have been used as props to support earthenware, and give access and circulation to the flames in the kiln. The like pieces of clay have, as an antiquarian informed me, been found in some of the Channel Islands, and a paper upon them exists in some periodical or transactions of some society. The use of these "hand-bricks" being pretty clear, I paid no further attention to them, until the subject of the works of "man primæval" began to be mooted, when the age of these bricks became an interesting question. I thought it worth while to make a few excavations on spots where the bricks were known to exist, and to try what could be learnt further about them. In the autumn of 1861 I made some fourteen or fifteen diggings, commencing under the strongest impression that the nodules were of very remote antiquity. The first excavation confirmed the view I had taken of the use to which they had been applied; they were surrounded by the débris of pottery, lying in every position, as if they had been thrown aside as useless and done with. As I proceeded I found nothing that threw any light upon the age of the hand-bricks, until the workmen, in almost the very last spadeful of the last excavation, threw up the bottom part of a pot, which, much to my disappointment, bore the marks of the wheel, and was clearly a piece of Roman pottery. The use, then, of these bricks, which may have been settled perhaps without my knowing it, is apparent; but their age I never heard any one hint at. They are Roman, and of no greater antiquity than the time of the sojourn of the Romans in Britain.

The men who dug for me recognized, as they said, the same appearances of "clay ashes" as are seen in the "staddles" or "straddles," where bricks are burnt in the present day in the marsh. I never myself, however, could discern a single piece of charred wood, however minute, or of coal, or any cinders, or any indication of vegetable matter acted upon by fire. I have an idea that the fuel used may have been straw or dried grass. Nothing was turned up of the nature of metal, coins, or tools; there were several drop-like pieces of a dark blue, almost black, glaze, transparent; the tooth of a horse; one of the tarsal bones of an ox or cow; two or three imperfect bones, probably of sheep; the remains of hazel-trees and willows, on the same level as the bricks: also, on the same level, cockle-shells, as though in their native bed; single oyster-shells; and, in one place, land-snail shells, as fresh and brilliant in colour as any now in a hedgerow.

In some few cases the hand-bricks are vitrified and hard; those that are not (constituting the great bulk of what I turned up) vary in colour from a light yellow-red to a dark black-red, and all seem more or less to have chopped grass or hay mixed with them. They vary in size; the smaller are near to Orby, the larger to the seacoast; the small ones are very friable and easily crumble. Flat pieces of pot-like floor-tiling exist, bearing the impress of grass on both sides, and seem to have formed a floor on which the props rested to support the pottery. Many of the bricks show a flat surface at one end, whilst the other end, that rested against the pot, is slightly hollow; there are other pieces of pot, of the use of which I could form no opinion. These relics of the Romans lie at very little more than a foot below the surface in Orby, at the point most distant from the sea; at other places they are three, four, five, six, and even close upon seven feet under the present marsh-level.

The superincumbent warp forms the rich marsh-grazing district of Lincolnshire. When examined, it can be split up into flakes, indicative of its being a tidal deposit, exactly like the warp left by the Trent and Ouse (Yorkshire) in the present day. I did not see a single freshwater or marine shell in the *body* of the warp; but when it is pierced through, a well-defined surface is reached having sea-shells upon it, and this surface was doubtless the Roman level.

I do not possess sufficient geological lore to reason firmly on the fact I have next to state; but the professed geologist will perhaps at once explain my difficulty. The first digging I ever made was in a field in Orby, the property of Mr. Stainton, of Dolby, called "the far ten acre." At about four feet we reached the bed of hand-bricks and débris, which were found to rest on a fine blue, plastic, saponaceous-like *clay*, into which a pole was thrust for three or four feet with ease. This clay must certainly have been the level of the district in the time of the Romans, for the hand-bricks lie upon it; it must, therefore, have been deposited *before* the Romans came to England, at all events before they made pottery on its surface, and very possibly out of its substance. If this clay is a sea deposit, which I take it to be, how comes it that the sea deposited a *blue* clay *before* the Romans came to Lincolnshire; and *after* they had left this country, when the banks gave way and the sea again submerged the Roman level, a *yellow-brown* warp, a very widely different substance from the blue clay, was left behind by the very same sea? Can any supposition of the blue clay being a freshwater deposit clear this up? Any such supposition appears to me to militate against the received, and I think the true idea, that the sea (not fresh water) once covered the Roman level, and that it was the sea, and not fresh water, that was embanked out by the Romans.

A considerable portion of the existing sea-embankment at Ingoldmells and Addlethorpe is not Roman, but modern, requiring constant attention. One of the hand-brick beds passes under this sea-embankment, and crops out upon the shore near to a house (formerly a public-house) now occupied by Mr. Waller. This spot cannot always be found, owing to the sands moving about with the state of the weather and tides, being sometimes covered for weeks and months, and sometimes left bare and exposed for like periods. The marsh in the time of the Romans, or rather the Roman level, is thus proved to have extended out into the sea, or what is now sea. At this spot the submarine forest is visible at low water (spring tides), and cannot, I think, be more than from twelve to sixteen or twenty feet below the level on which the hand-bricks rest, and may be much less. At this part of the coast there is, as Mr. Clarke says, a complete interlacing of archæology and geology. At low water you have the marine forest, admitted on all hands to have undergone geological depression, standing, as I believe, on a blue clay. What intervenes between the forest and the level of the hand-bricks I cannot say, but I believe it also is blue clay; whatever it is, on it rest the hand-bricks; and finally, over them is deposited the sea-warp, forming the marsh-land of East Lincolnshire.

I fear I am trespassing too much on your columns. I will only add that the bricks picked up upon the seashore are indifferent specimens, having always suffered from the action of the sea; if more is required to be known about them than their use and date, which I think are clear, it must be obtained from diggings made between Orby and the sea.

In writing to you, my object is to support Mr. Clarke's views. I feel confident that whoever will make researches in the district of Orby, Ingoldmells and Addlethorpe, will find much that is curious, whether he is an antiquarian or a geologist, and very likely contribute his mite to the common fund of knowledge.

Yours obediently,
G. S. D.

Lincoln, April 23rd, 1863.

New Species of Olenus.

Dear Sir,—I have much pleasure in informing your readers that a new species of Olenus, named *O. pecten* by Mr. J. W. Salter, has been found in the Black Shales (Lingula flags) of Malvern by a village schoolmaster, Mr. Turner, of Pauntley, near Newent. Mr. Turner was so good as to present me with his newly-discovered treasure, and I have given this beautiful little trilobite to the museum at Jermyn Street, and the cast to the museum at Worcester; so at either of these places the student of Silurian geology may see the specimen. I may also mention that I was presented last month with some well-preserved bones—the humeri, I imagine, of the Labyrinthodon—by Henry Brooks, shoemaker, of Ledbury. This specimen I have also sent to the Worcester Museum.

I mention these facts, as they are encouraging to those geologists and naturalists who are engaged in such constant occupations as day-school keeping and shoemaking, and who have little leisure or time at their disposal.

Yours very truly,
W. S. Symonds.

Pendock Rectory, Tewkesbury, May 6, 1863.

Causes of Cosmical Changes of Temperature on our Planet.

It is admitted that the possible changes in the present meteorological conditions of our planet could not account for the great fluctuations of temperature recorded in the geological history of the glacial periods. Mr. S. J. Mackie, in the last number of the 'Geologist,' attributes these changes of temperature to changes of size of the sun's disk, to maximum and minimum periods of solar heat, etc. etc. It is clear these explanations, although possible, are purely arbitrary, mere speculations, unsupported by any cosmical or physical facts. Now, it is known that our solar system is travelling in space towards the constellation Hercules at the rate of 57½ miles a second; yet so great are star-distances, that thousands of years elapse before our visible position in the heavens be changed to the naked eye. From the observations of Glaisher in his balloon ascents, it appears that the decrease in temperature is not in direct proportion to the distance from the earth; but, on the contrary, that a hundred feet elevation at the earth's surface produces as great refrigeration as a thousand feet at a greater elevation. It necessarily follows that we must arrive at cosmical temperature beyond the influence of atmospheric changes; but is this cosmic temperature uniform through the portions of space destined to be traversed by our solar system? If there be portions of space of different cosmical temperatures through which our planet has passed, this would account for the great cold of the glacial periods in a way supported by one strong fact, which is, that our position in the heavens is changing at the rate of 57½ miles a second, and for this change of position not to affect the heat of our earth, we must suppose the cosmical temperature of space so traversed by our earth to be uniform, which would be a most arbitrary supposition. It is quite possible, nay even probable, that not only our own solar system, but all visible creation, the infinite and countless stars,—so remote, that their light has taken millions of years to come to our eye,—are all revolving through space around some almost infinitely far-off centre, which if luminous, its light is so attenuated by distance as to be invisible to us, and that the period of such a revolution may be long, beyond all calculation, during which immense portions of space must be traversed, most likely of unequal cosmic temperature, quite sufficient to account for the glacial periods in the geological history of our earth. There is nothing fanciful in this view, or beyond the range of probability. The vast magnitude of such a system is no objection to its existence, for, in comparison with infinity, all assignable distance or magnitude shrinks into a mere point. The immense period necessary for such a revolution would afford ample time for all the glacial formations recorded by geological observation, by admitting only the natural supposition that the temperature of infinite space is not uniform. Yours, etc., DAVID LESLIE, M.D.

Carrickmacross, Ireland, May 21, 1863.

[It is not the intention of the Editor to reply to comments on his articles in all cases separately, but in one or two respects Dr. Leslie's letter requires notice. Mr. Mackie distinctly put forward the views in his paper as *speculations;* but Dr. Leslie is wrong in saying they are all unsupported by physical or cosmical facts. Neither is it admitted that possible changes of meteorological conditions could not have produced the cold of the glacial era. It may have been dogmatically asserted so. We should be glad to learn what temperature Dr. Leslie thinks existed then, and what were the fluctuations it was subjected to. We should also be glad to know on what grounds the idea of hot and cold regions in space can be maintained; and why the cosmical temperature of space should not be the real zero of temperature, or a condition of absence of all heat. We should like to know what is the presumed temperature of the cold cosmical space through which our globe is so hypothetically supposed to have passed in the glacial age.—ED. GEOL.]

FOREIGN INTELLIGENCE.

The Abbeville Human Jaw.

When we noticed last month the discovery of a human jaw at Moulin-Quignon, we did so with the utmost caution. We knew perfectly well how long and how keenly M. Boucher de Perthes had sought for human relics in the gravels around Abbeville, and we could scarcely believe that the indefatigable collector, who for thirty years had resided on the spot, could not know the difference between a spurious and a real fossil. On the other hand, we had the letter of Dr. Falconer to the 'Times' before us, and Messrs. Prestwich and Evans, after a journey of inspection and examination, had returned disclaiming the discovery. We seemed thus compelled by adverse testimony to repudiate the discovery; but still we were not satisfied with the premises upon which the adverse conclusions had been founded, neither, on the other hand, could we advocate the genuineness of either the jaw or the flint-implements, for there were circumstances connected with both that made us hesitate. The flint-implements, although of the usual size, namely, six or eight inches long, were not left as usual in their natural state and unworked at the broad end, but were clipped all round; and the strong point urged by Dr. Falconer, of the presence of gelatinous matter inside the solitary molar, which was supposed to have fallen from the jaw, was, though not conclusive against the fossil, still a barrier against an advocacy of the genuineness of that specimen, and, by inference, of the jaw. Since then, M. Quatrefages has made his report to the Paris Academy of Sciences, and has unequivocally declared in its favour. M. Quatrefages' first communication was made to the Academy on the 27th of April, and the following notice of it was given in the 'Institut:'—

"M. de Quatrefages brought then before the Academy a very interesting palæontological fact—the discovery of a lower human jaw, in the same diluvial sands at the base of which have been found during some years numerous worked flints, thanks to the incessant researches continued with such indefatigable zeal by M. Boucher de Perthes. M. Quatrefages submitted for the inspection of the Academy the jaw itself, surrounded still with a part of the matrix which enclosed it. It was at Moulin-Quignon, near Abbeville, that the discovery was made in the deposit already many times quoted in the publications of M. Boucher de Perthes, and of which the natural or undisturbed state is universally admitted by geologists, both French and foreign, who have visited the locality. M. de Quatrefages had been informed of the discovery, and M. Boucher de Perthes had requested him to communicate it to the Academy, but he would not do this until he had seen it with his own eyes. He went to Abbeville as soon as possible, and met there Dr. Falconer, with whom he proceeded to make a first examination of the human jaw. The two naturalists then visited the localities and proceeded to make a sort of inquiry. Dr. Falconer had already been to the quarry of Moulin-Quignon. M. de Quatrefages now descended into it in his turn, and clearing away the soil himself to make certain of getting at earth not attacked by the workmen, he struck into it with a pick. Soon he perceived amongst the detached gravel-stones a first *hache* and almost immediately a second. He would have continued his search but that the excavation was already so deep that a slip or falling-in was dreaded; it was prudent to stop. The next day Mr. Brady found in the same place a fourth implement.

M. de Perthes wishing to confide to M. de Quatrefages the precious relic, the latter has made a detailed examination of it. . . . At present it is sufficient to indicate the following general results :—M. de Quatrefages is convinced that the jaw discovered by M. Boucher de Perthes belongs really to the bed in which it was discovered. It is then a fossil, in the general sense of the word. Geologists discuss still the age of these beds. M. de Quatrefages, who is not a geologist, declines entering this part of the question, and only occupies himself with the anthropological phase. In this point of view, the characters of this jaw have nothing remarkable. The differences which separate it from analogous parts in existing races, are less than those which can be noted between one and the other of the latter. This jaw is not that of a negro, and it presents absolutely nothing which would support the theory that would make man to be descended from the ape by means of a progressive development."

This communication appearing almost simultaneously, but irrespectively of, the letter of Dr. Falconer to the 'Times' which we printed in our last number (p. 189), M. de Quatrefages returned again to the subject at the next meeting of the Academy on the 27th of April, and, referring to the doubts of Dr. Falconer and the English geologists, critically re-discussed the circumstances and the grounds for these doubts, asserting that he could find nothing in the latter that could withstand a profound examination.

The only right thing which could be done under these circumstances has been done. A congress of *savants* has been held to discuss and decide the question. They first met at Paris, but transferred their assembly on the 11th of May to Abbeville itself. The congress consisted of M. Milne-Edwards, member of the Institute, and senior member of the Faculty of Sciences, to whom the presidency of the meeting was unanimously awarded; M. de Quatrefages, member of the Institute, and professor of the Museum of Natural History; M. E. Lartet, member of the Geological Society of France; M. E. Delesse, engineer of mines, and professor of geology at the Normal School; the Marquis de Vibray, member of the Institute; M. E. Hébert, professor of geology at Sorbonne; M. J. Desnoyers, member of the Institute, and Librarian of the Museum of Natural History; the Abbé Bourgeois, professor of geology at the College of Pont-Levoy; Dr. F. Garrigall, member of the Geological Society of France; M. Albert Gaudry, naturalist at the Museum of Natural History; M. J. Delanoue, member of the Society of Antiquaries of France; M. Alphonse Milne-Edwards; Dr. Falconer, Fellow of the Royal Society, and of the Geological Society of London; Mr. Prestwich, Fellow of the Royal Society and of the Geological Society; Professor Busk, Fellow of the Royal and other Societies; Dr. Carpenter, Fellow of the Royal Society and Professor of Physiology at University College, etc. The result of the inquiry was, that the Congress admitted that the jaw found on the 28th of March, by M. Boucher de Perthes, at Moulin-Quignon, is truly fossil; that it was extracted by M. Boucher de Perthes himself from a virgin and undisturbed bed; and that the implements that it had been supposed had been fabricated by the workmen are incontestably ancient.

The *savants* of both nations united in a deputation to convey the intelligence, and to congratulate M. Boucher de Perthes. The local newspaper, the 'Abbevillois,' says :—"We cannot too highly applaud the scrupulous care these eminent men have given to this interesting inquiry on a point so important to our history, and confirming all that tradition tells us of the Biblical deluge, and of the existence of man at the epoch when that great cataclysm altered the face of the earth. The English members of the commission, and we thank them for it, have shown a real devotion to science in quitting their business to join the French professors and aid them with their opinions. The frank cordiality, the good faith and impartiality that they have shown in the discussion, is above all praise. . . . Dr. Falconer, the great English palæontologist, and Messrs. Prestwich and Busk, whom all the world know by their fine works, have gained for themselves much honour. Our town ought to be proud of the *réunion* within its walls of such men, so justly esteemed in France, as well as in England. On the 14th, M. de Cailleux, member of the Institute, and director-general of museums; Professor Edward Collomb, the well-known mineralogist; M. Hébert, who had already come to the deliberations of the 12th, and other Parisian notabilities whose names we regret we do not know; and lastly, a party of pupils of the learned professor of the Sorbonne have arrived and visited our beds, now become so celebrated, and the galleries, not less known, of M. Boucher de Perthes. We see that this discovery of antediluvial man, which in other times would have passed unperceived, has become a truly scientific ceremony.

"In the sciences, as in everything else, the slightest circumstance may serve to resolve a great question. Mr. Busk, the celebrated English chemist and naturalist, who came to Abbeville with Messrs. Falconer and Prestwich, making, on the 12th of this month (May), some experiments on the argillaceous 'black bed,' which contained the jaw and *haches* from Moulin-Quignon, let fall on the ivory handle of his penknife a drop of the black earth wetted with water. On the morrow it had dried, and presented a metallic reflection. Having washed it, he perceived that the handle of the knife remained perfectly white. This explained to him the non-coloration of the implements, and the whiteness which had been preserved in the interior of the jaw. This earth, having no staining or penetrating qualities, could not alter their surfaces. Mr. Busk immediately acquainted Messrs. Prestwich and Falconer, who concurred with him and adopted his opinion. It was this appearance of newness, which however is not an unusual case, that on his (former) return to England had engendered the (then) conviction of Dr. Falconer. He believed, for a time, in a *ruse* of the workmen; but, equally conscientious as learned, and never recoiling from the truth, the eminent palæontologist exhibited a real joy when his doubts were dissipated and he was able to proclaim the innocence of the workmen. Honour should be rendered to Dr. Falconer, who, in this discussion, in London as in Paris and at Abbeville, has given proof not only of a profound knowledge but of a probity and courage which French and English alike admire.

"Messrs. Prestwich and Busk, Dr. Carpenter, and Mr. John Evans, although the latter could not come to France to this second meeting, have shown the same dignity of character. We applaud these men, who thus do honour both to science and to their country. Amongst those who have thrown most light in this discussion must be mentioned the president of the commission, M. Milne-Edwards, M. de Quatrefages, the celebrated professor of anthropology, and M. E. Lartet, who for five-and-twenty years has made such great progress in palæontological investigations. These gentlemen have supported, without ever varying, the authenticity of the human fossil and the antiquity of the *haches*.

"A very simple incident had tended more than anything else to enlighten M. de Quatrefages. M. Boucher de Perthes had, on the 28th of March, extracted the jaw from its bed before numerous witnesses. The workmen, who expected to see some monstrous bone appear, as at Menchecourt, were confounded at the apparition of so small an object, and which, enveloped in its *gangue*, did not even appear to them to be a bone at all. M. Boucher de Perthes having disengaged a part from its envelope, made them seek for the other half, and gave them five francs, promising them double if they found the other half or any other portion of the skeleton. This offer he has renewed many times, and even offered treble the first. However, although they have made many researches, they have not since the 28th of March brought to M. Boucher de Perthes a single fragment of human bone. Now, doubtless, if they had buried the first, they would have largely supplied afterwards, not only M. Boucher de Perthes, but all the amateurs who have asked for specimens."

With regard to this last proposition, we do not however see the force, because if the workmen had been encouraged by rewards—as indeed they had been by M. Boucher de Perthes—to find human remains, a solitary skull was much more easily obtainable by them than a whole skeleton, and a bit of jaw much more so even than a skull; and, therefore, it might be on the other hand said that the not finding of further remains was confirmatory of a *ruse* having been practised. The force of the discovery does not however rest on this point. The question is not a question of suspicion against the workmen but of positive evidence from the witnesses who saw M. de Perthes extract the jaw from its bed. These witnesses must be trustworthy or not; either they did see the jaw in its matrix before extracted, or they did not; either they did see M. de Perthes take it out from thence, or they did not. What do these witnesses say? What does the world say of them? Were they not capable, intelligent, honourable men,—not illiterate bumpkins whose eyes and tongues we might hesitate to believe?

For M. Boucher de Perthes himself nothing can be more open, more straightforward, than his conduct; and the same, we think,—whatever be the state of the jaw or the conclusions we may come to from its study,—must be said of the workmen. They knew that every fragment of bone, even of animals, was deemed of value by their patron, and as soon as they saw an inch of bone appearing in their diggings they go and tell him; they do not call it human, they make no fuss about it. M. de Perthes goes to see it. He goes to see every bit of bone they tell him of; he may have gone similarly scores of times before, but this time he perceives, as any educated man would do, that he has got a bit of a human jaw; the workmen, expecting some great bone of mammoth or other ancient wild beast, are astonished at its smallness, still more so to learn what it is. M. Boucher de Perthes orders it not to be disturbed, not to be touched; he fetches the most competent of his friends, members of the local but well-known Société d'Emulation, men at least capable of using their eyes and of giving truthful and accurate testimony; and in their presence he clears away the soil and takes out the jaw, leaving the still adherent earth upon it. Certainly, if such a discovery is to be ignored on suspicion, it will be hard to accept any fact at all in quaternary geology, and not half the facts in geological science which are based on far less conclusive testimony. If we object to the testimony in this case, we could only get better by finding the jaw over again.

The 'Moniteur' also comments on the late scientific tourney. It says: "The human jaw which has been recently found near Abbeville, in the diluvium,—a geological bed in which hitherto no similar vestige has been discovered,—has been photographed by M. P. Potteau, preparator at the Museum of Natural History, to whom we owe already an interesting collection of types of different human races. We have before us two proofs representing the two faces of this curious relic of a generation whose existence dates, in all probability, beyond the historic period. It is the half only of the inferior maxillary, in a state of preservation really extraordinary according to the observations which have been made, and which we owe to the good offices of M. de Quatrefages. This jaw belonged to an aged man of small size; which would prove that the human race did not possess at its origin those gigantic proportions which some hypotheses have assigned. The angle of the exterior contour is more open (obtuse) than in modern types; but in examining two Esquimaux jaws, it was seen that in one this angle was much more open still, and in the other much less. This is then only a character belonging to the individual. A molar tooth, which remains in place, appears also more inclined forwards than in ordinary cases; but this fact is explained by the absence of the neighbouring tooth, which had been extracted or had fallen out during life; for the process of ossification had taken place, as it always does, in the alveolus. This then again is only an entirely individual character. Other important observations which can be repeated, or the photographic portrait itself, have given the like result.

"The discovery of this fossil jaw has given rise to a veritable scientific tourney between the French and English *savants*. If the victory has been gained by the former, their adversaries have had the rare merit, in duels of this kind, to acknowledge loyally and courteously their defeat. To give an idea of the minuteness of the investigations to free the matter from any doubt which might exist, we summarize some of the curious details which have been kindly furnished by Messrs. de Quatrefages and Milne-Edwards, jun.

"After having examined the jaw found by M. Boucher de Perthes, M. de Quatrefages went to Moulin-Quignon, where he made some cuttings to study the earth. He caused the quarry to be cleared, and gave in front of himself a blow of the pick in its wall (or face) at the height of the bed where the discovery had been made. Stones were detached, and amongst those which fell was found a flint *hache*, like those of which we possess already numerous specimens. On examining the wall in the gap which had been thus made, M. de Quatrefages saw then nearly entirely embedded a second *hache*, which he detached himself. This, at least, could not have been fraudulently introduced, and its presence was a guarantee for the authenticity of the human débris found in the same place. Hence the learned Professor made his first communication to the Academy of Sciences. Dr. Falconer came to Paris, studied the implements and the jaw, and went away convinced. However, after some days, and fresh observations, he published in the 'Times' the letter we have read,* and which expresses more than a doubt. M. de Quatrefages took then the study he had made, and replied by new and critical arguments to his *confrères* across the Channel. They decided then they would come to Paris, to undertake, in concert with the persons that were named, investigations which M. Milne-Edwards had spoken of in his communication to the Committee of Learned Societies.

"Three principal points formed the basis of the doubts of the English Professors,—the nature of the *gangue* which enveloped the jaw and the implements, the freshness of the edges of the latter, and finally, the presence of a little sand in the alveolus where the dental artery passes. M. Delesse declared it was impossible for any chemist to counterfeit exactly the material of the *gangue*. This, moreover, had penetrated into the alveolus, and had there deposited itself in a way it was not possible to imitate. Five implements were found successively in the presence of the parties conducting the inquiry, and they all† had the same characters as those previously extracted. Lastly, at the top of the 'black bed,' where the maxillary bone reposed, a sand was found exactly like that noted in the alveolus.

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* Printed in our last number, p. 189.

† With one exception, see p. 223.—Ed. Geol.

"After these evidences, the English *savants* declared themselves convinced that the jaw had not been introduced fraudulently in the bed of diluvium, and that it was contemporary with the material which formed that bed.

"As to the question as to what is the age of that deposit, that remains to be resolved.

"Thus has terminated this interesting debate."

Since Dr. Falconer's return to England, he has communicated the following letter to the 'Times' of the 21st ult., and which we give at length, as the appendix he has thought fit to make to the unanimous conclusions of the congress must open afresh the question of the age of the Moulin-Quignon deposits:—

"SIR,—In my letter which appeared in your issue of the 25th ult., I stated that the case of the Moulin-Quignon human jaw presented in its then stage, as a whole, 'one of the most subtle instances of perplexed evidence on a point of science that has come under my experience.' It has since undergone an investigation at Paris and Abbeville by a joint commission of French and English men of science, throughout which it maintained the same perplexed and contradictory character, not to be surpassed, in some respects at least, by any *cause célèbre* on record. But I am happy to say that upon one point, which it was of the last importance to clear up, the commission, French and English, were unanimous,—namely, that the discovery of the remarkable human relic *in situ*, in the gravel-pit of Moulin-Quignon, was authentic, and that no imposition had been practised by the workmen in the case. As an inference to the contrary on the part of myself and my scientific friends was distinctly expressed in my former letter, I am desirous that there should not be the slightest reserve in withdrawing it. What now remains to be established is the precise age of the relic. This part of the case is still involved in obscurity, and so beset with contradictory and apparently incompatible evidence, that its satisfactory solution is at the present moment of the utmost difficulty.

"The voluminous *procès-verbaux* of the commission will appear in due course. Here I shall merely give a brief summary of the proceedings, prefacing it with a short *résumé* of the events which led to the conference.

"On the 14th, 15th, and 16th of April, I was at Abbeville, where, on the 14th, I met Dr. Carpenter, and on the 15th M. Quatrefages. I communicated to both my then impression, subject to the reserve of a more detailed study of the materials, that the jaw was an authentic fossil, and on the 15th I wrote to the same effect to my friend M. Lartet, to whom the jaw was consigned in Paris. On the 16th Dr. Carpenter gave a short paper to the Royal Society, supporting in guarded terms the authenticity of the discovery; and on the 20th of April M. de Quatrefages communicated to the 'Institut' a memoir by M. Boucher de Perthes, followed by descriptive remarks by himself, conveying the high authority of his opinion in favour of the jaw being a true fossil of geological antiquity. On Saturday, the 18th, immediately after my return to London, I commenced the scrutiny detailed in my former letter, and on the 21st, in conjunction with, or aided by, Mr. John Evans, Mr. Prestwich, Mr. Busk, and Mr. Tomes, I arrived at the results which are there stated. That day, without the delay of a post, I communicated my suspicions to M. Lartet, requesting him to make them, and the grounds upon which they were founded.

known to M. de Quatrefages. But the latter had already given in his affirmative memoir to the 'Institut' the previous day (20th), followed on the 27th ult. and 4th inst. by successive notes in the same sense. On the 25th of April, my letter, written before I was aware of M. de Quatrefages' first communication, appeared in your columns. Men of science in France and England were thus suddenly placed at direct issue on a grave and important point, which excited lively general interest on both sides of the Channel. But, happily, from the frankness and rapidity of the communications interchanged, there existed the most cordial relations, and the conviction of loyalty and good faith on both sides. The French *savants*, the more they went into the case, were the more convinced of the soundness of their conclusions, while their English opponents, the more they weighed the evidence before them, were the more strengthened in their doubts. A wordy discussion on paper would have wasted time, and it must have been protracted. On the 15th inst. I received an invitation from M. Lartet to proceed to Paris with my colleagues, and Dr. Carpenter got one from M. de Quatrefages to the same effect,—the parties named were Messrs. Prestwich, John Evans, Carpenter, and Falconer,—to discuss and investigate the question, along with M. de Quatrefages, member of the Institut; M. Lartet, member of the Geological Society of France, and foreign member of the Geological Society of London; M. Delesse, Professor of Geology to the Ecole Normale, Paris; and M. Desnoyers, member of the Institut. Dr. Carpenter and myself at once determined to accept the invitation, and Mr. Busk agreed to accompany us. Unfortunately, Mr. Evans, the strength of our array on the characters of ancient flint-implements, could not go, and Mr. Prestwich was unable to join us until the second day of the conference. The English deputation reached Paris on the 9th inst., and immediately proceeded to business. The commission was formed, consisting of the parties above named, aided by the following French *savants*, who took a share in the proceedings throughout, viz. M. l'Abbé Bourgeois, M. Gaudry, and M. Alphonse Milne-Edwards. At the request of the English, M. Milne-Edwards, member of the Institut, and the eminent zoologist, courteously agreed to preside over the commission. The following particulars are given from notes and recollection, we not having yet received a copy of the *procès-verbaux*.

"The first two meetings, one of which lasted nearly six hours, were devoted to the characters which distinguish genuine flint-implements of antiquity from modern imitations. The English deputies presented about twenty flint *haches* from the gravel-pit of Moulin-Quignon, and the majority of them found within the last three months, the whole of which they insisted bore the characters of comparatively modern manufacture, so great was their freshness and sharpness, while they were wanting in the *patina*, superficial incrustations, dendrites, and rolled edges, one or more of which, as a general rule, stamp the majority of genuine specimens. The French members of the commission submitted nearly an equal number of a similar cast from Moulin-Quignon, the majority of which also the English regarded as unauthentic. A few specimens from Moulin-Quignon, but of earlier discovery, were presented and admitted as genuine on both sides.

"The 'detached molar' which had previously been sawn up by me, and upon which so much weight was rested by the English observers, was at once abandoned, by the consent of both sides, from the circumstance that it was open to question on the score of identification, or of certainty as to its origin. This in the sequel proved to be immaterial.

"The characters presented by the jaw itself were then examined. The dark matrix enveloping it (mangano-ferruginous) was regarded on the one side as being natural, while on the other it was urged that it might have been laid on artificially. The jaw was carefully sawn across by Mr. Busk, and the section so conducted as to include a portion of one of the fangs of the solitary tooth. The black coating was washed off readily by means of a sponge, and the residuary spots in the minute hollows were removed by the aid of a tooth-brush. The general colour of the washed surface was a light buff, mottled with brown stains. The outer surface was tolerably smooth, presenting little indication of the superficial erosion commonly seen in old buried bones. There was no appearance of dendritic patches either on the exterior or within, and no infiltration of metallic matter. The substance of the bone was dry and friable, especially towards the alveolar border; but, on the whole, it was tolerably firm under the jaw, and the fresh section afforded a distinct odour of sawn bone. The internal cancellated structure was of a faint brownish tinge, and the cells free from any incrustation. The most remarkable appearance observable in the section was the lining of the dental canal with a thin layer of fine grey sand, free from admixture with the black metallic matrix which blocked up the orifice of the canal below the condyle. The section of the fang showed that the dentine, so far as exposed, was white, and in no respect different from that of a recent tooth. The enamel was white and brilliant. The socket towards the upper part was not completely filled by the fang, and the interval was partially occupied by black matrix and sandy particles. The above descriptive remarks are extracted from the notes of Mr. Busk. The commission was too pressed for time to wait for a chemical analysis.

"Here terminated the labours of the commission at Paris on the 11th inst., and, so far, no point had been established to shake the confidence of the English members on the soundness of their doubts as to the authenticity of the flint *haches* and of the human jaw. Two, at least, of the four French members frankly and openly admitted the effect which the evidence yielded by the section of the latter had produced on their views; and had the inquisition been carried no further, it is probable that the result would have been a verdict of 'not proven.' But, happily for the interests of truth, the President, M. Milne-Edwards, had, after the close of the second *séance*, proposed that the commission should visit Abbeville, to examine on the spot the evidence as to the *gisement* in which the *haches* and the jaw were asserted to have been found. From the moment when the commission got to Abbeville, the whole aspect of the case was changed. A party of sixteen workmen were employed from 7 a.m. to 5 p.m. with pickaxes, under the closest inspection, to cut into the undisturbed body of the section, and during the course of the day five flint *haches* were discovered *in situ* under circumstances which made it impossible to doubt the authenticity of their natural position in the cliff. I was an eye-witness, with many others, to the disengagement of two. And what struck the English members with especial force was, that of these five *haches* only *one* presented the characters which they held to, as distinctive of genuine specimens of great antiquity; the other *four* were identical in their general appearance with those which in the previous meetings of the conference they had considered to be unauthentic. If the former were adjudged to be authentic, the decision carried with it the latter which had been rejected. The evidence regarding the occurrence of the jaw in the 'black band' was then considered, and it appeared to be supported by such direct testimony, that it was unanimously accepted by the commission.

"During the last two days the English members were reduced to three, Dr. Carpenter having returned to London. At the final meeting, held on the 13th inst., the following conclusions were adopted:—

"'M. le Président, après avoir résumé la discussion, met aux voix les conclusions suivantes:—

"'1. La mâchoire en question n'a pas été introduite frauduleusement dans la carrière du Moulin-Quignon; elle existait préalablement dans l'endroit où M. Boucher de Perthes l'a trouvée le 28 Mars dernier. Cette conclusion a été adoptée à l'unanimité.

"'2. Tout tend à faire penser que le dépôt de cette mâchoire a été contemporain de celui des cailloux et autres matériaux qui constituent l'amas argilo-graveleux, désigné sous le nom de 'couche noire,' laquelle repose immédiatement sur la craie. Cette conclusion a été adoptée par tous les membres présents, à l'exception de MM. Falconer et Busk, qui réservent leur opinion jusqu'à plus ample informé.

"'3. Les silex taillés, en forme de haches, qui ont été présentés à la réunion comme ayant été trouvés vers la même époque dans les parties inférieures de la carrière du Moulin-Quignon, sont pour la plupart, sinon tous, bien authentiques.

"'Cette 3ème conclusion a été adoptée par toutes les personnes présentes sauf par M. Falconer, qui réserve son opinion jusqu'à plus ample informé.

"'4. Il n'y a aucune raison suffisante pour révoquer en doute la contemporanéité du dépôt des silex taillés avec celui de la mâchoire trouvée dans la 'couche noire.'

"'Cette proposition est adoptée par tous les membres de la réunion sauf par MM. Falconer et Busk, qui désirent réserver leur opinion.'

"Before signing the *procès-verbal*, I handed in to the President the following memorandum, to be appended to the report, as embodying my opinion upon the whole case:—

"'I am of opinion that the finding of the human jaw at Moulin-Quignon is authentic; but that the characters which it presents, taken in connection with the conditions under which it lay, are not consistent with the said jaw being of any very great antiquity. 'H. Falconer.

"'*Abbeville, May* 13.'

"Mr. Busk also handed in a memorandum, differently worded, but virtually to the same effect as regards the question of antiquity.

"The above is a bare outline of the principal features of this remarkable inquiry. The full discussion of the bearing and import of the conflicting evidence on the various points, and of the geological questions involved in the case, must be given elsewhere. It will be seen that in the judgment of some of those concerned in it the question of the antiquity of the relic still remains to be determined.

"I have only to add that we were received, both at Paris and Abbeville, by the eminent French *savants* with whom we were brought in contact, in the most cordial and friendly spirit; and the conviction was reciprocal that, throughout, both sides were influenced solely by an earnest desire to arrive at the truth. Sir, your obedient servant,

"H. Falconer, F.R.S.

"21, *Park Crescent, N.W., May* 19.

"P.S. Dr. Carpenter, although named as a commissioner, both in the French and English accounts of the proceedings, wishes it to be understood that he took no part in the discussion upon the flint *haches*, as to the genuineness of which he did not consider himself competent to form an opinion; but he had been sufficiently impressed by the unanimous conviction of the English experts as to their modern character, to have come to doubt his original belief in the authenticity of the *jaw*. H. F."

We will now return to M. de Quatrefages' paper before the French Academy, as the particulars are interesting, and one point is worthy of some consideration.

" The jaw was found . . . in an undisturbed quaternary deposit at Moulin-Quignon, near Abbeville. Below is the section of the beds :—

" SECTION AT MOULIN-QUIGNON.

	Metres.
1. Coating of vegetable earth	0·30
2. Undisturbed earth, grey sand mixed with broken flints . . .	0·70
3. Yellow argillaceous sand mingled with large flints slightly rolled, resting on a bed of grey sand	1·50
4. Yellow ferruginous sand, flints more or less rolled like the preceding, below which is a bed of sand less yellow. In this bed have been found fragments of teeth, etc., of *Elephas primigenius* and flint-implements	1·70
5. Black sand, argillo-ferruginous, colouring the hand and adhering to it, apparently containing organic matters ; small pebbles more rolled than in the superior beds ; fossil human jaw . .	0·50
	4·70
6. Bed of chalk on which reposes the bed of black argillaceous sand at a depth of 5 metres below the surface.	

"The argillo-ferruginous bed in which the jaw was found varies in places from 0·30 to 0·60 metre in thickness. No part of it is confounded with the beds above, and it follows all the undulations of the chalk under it ; thus it may be said to lie at a depth of from 4 to 5 metres from the surface. . . .

"The jaw is in a remarkable state of preservation. It does not appear to be at all rotted. The extremity of the coronoid apophysis itself is intact. This fact would make one think it had not come from far, and would give the hope that there may yet be found some other part of the skeleton of which it formed part. M. de Perthes has desired that the greatest respect may be paid to the *gangue* which still adheres to some points of the surface ; he has washed the extremity of the coronoid apophysis and a part of the head of the condyle. There one perceives that the brown tint which the whole bone presents has not penetrated deeply. Gravel-stones washed with care have presented a similar peculiarity. The *gangue* conceals some details, especially on the internal side ; but it permits, however, a sufficiently complete study. When we examine this jaw, we are at once struck with two peculiarities--the angle formed by the horizontal ramus and the ascending ramus is extremely open ; the fourth molar, which alone is in place, is slightly inclined forward. These two traits had been even somewhat exaggerated in a drawing which was first sent to me, and perhaps to this cause is due the attention which from the first they have elicited from me. Should we see there a race-character ? Before examining in this point of view, let us remark that for man, as for animals, the comparative osteology of races, in respect to details, is still very little advanced. It is a new study, to which palæontologists are necessarily put as well as anthropologists, by reason of the facts which tend to bring into contact the history of animals and that of man. The obtuseness (*ouverture*) of the angle of which I speak is one of those traits that age and perhaps other circumstances, and, moreover, even individual conditions, cause considerably to vary. Amongst the specimens in the gallery of the Museum, I have found that in one head of an Esquimaux it is perhaps much greater than in the jaw from Abbeville, whilst in another head of the same race it is nearly straight. I have elsewhere found in different races other examples of an angle as obtuse, and of analogous variations. A fresh study and exact measurements taken of many individuals of different ages and races are still necessary.

"Is the inclination of the tooth a race-character? It is easy to answer this question by examining the alveoles of the incisors still intact. These prove a vertical implantation. The inclination of the incisors has certainly nothing different from what we observe in races the most strongly orthognathous. This is a very important fact, for it tends to resolve a contested question. Some anthropologists, amongst whom are men that I respect equally for their judgment and science, have thought that the negros—that is to say, races essentially prognathic—should be nearer the primitive type of humanity, and that the superior races have taken their birth through a progressive development; that they are, in consequence, posterior to the negro. Now in 1861, in my lectures at the Museum, I laboured to show that present science furnished but few facts, and those vague and conjectural, on the characters possessed by primitive man; but that it permitted us to specify, almost with certainty, some of those which he did not possess. In dwelling upon the phenomena of Atavism, and on the principles of philology, I believed I was able to affirm that the negro race was not the first to appear; that the white, however high he might carry back his genealogy, would never find the negro amongst his ancestors. The orthognathism of the Abbeville fossil adds one argument to, and more serious than those which I had then estimated. The man to whom this jaw belonged was the contemporary of elephants and rhinoceroses which have become extinct, if we may admit the opinion of many eminent geologists. In any case, it remains at present the representative of the most ancient races known; and nothing in the disposition of his teeth indicates that prognathism which is the essential character of all the negro races, and which they transmit in inter-breeds with such great persistence.

"I believe myself, then, more and more authorized to repeat, that the negro and the white represent the extreme modifications of a primitive type which was placed somewhere between the two. As to the inclination of the molar in the Abbeville fossil, there is certainly nothing characteristic in it. On the one hand, I have found analogous facts in many heads of different races in the collections of the Museum. On the other hand, the inclination appears to me to be here the result of an accident. The molar placed in front of that which remains had fallen out while the individual was living. The alveolus has been filled up by the process of ossification which takes place in that case. One comprehends that, before this filling in, the tooth placed behind the void could be pushed or drawn easily in the direction where it no longer finds the usual support.

"Dr. Falconer, with whom I had the advantage of examining the jaw, was forcibly struck with the following peculiarity. The edge of the angle of the jaw and the posterior portion of the inferior border of the horizontal ramus curved slightly inwards. The internal base of the bone presented thus, below the oblique line, a sort of canal, or rather of large gutter, extending as far as the vicinity of the chin, and sensibly more pronounced than it was in a modern jaw placed by a dentist at our service. I have sought in this respect for facts which might be afforded by the gallery of anthropology. I have found very marked traces of inversion inwards of the angle of the jaw in a Bengalese, a Javanese, and a Bellovacian (Belgian); indications only in a Laplander, a young negress, and an Egyptian mummy. In opposition to this, an aged Egyptian mummy and a New Caledonian have exhibited this trait very decidedly, and in a Malay of Batavia it is as marked as in our fossil, or very little less. Thus different human races present all degrees of this character: but at the same time the inverse character presents itself in the majority of individuals of all races.* New comparisons are necessary, without doubt, to appreciate the value and the signification of these characters.

"To what causes belong these contrary dispositions? Without wishing to be too positive, I see in them, at present, the effect of the action of the masseter acting outside, and of the internal pterygoid acting inside. The relative weakness of the latter explains why the masseter ordinarily prevails. Their accidental preponderance would be caused by the habit of *grinding* the food, a habit which persons advanced in age often have. This last observation was made by M. Jacquart, Assistant Naturalist to the Chair of Anthropology. As to the canal or gutter, we only see there an exaggeration of that which exists normally. It is, indeed, at this point that we find the channel designed to contain the submaxillary gland. The inflection of the edge of the bone alone renders it more prominent and deeper. The same *savant* called my attention in a special manner to the form of condyle. The inferior internal border of its head is here, indeed, very little marked. Its head is, moreover, perhaps more rounded and larger outwards than ordinary; but these peculiarities cannot be considered as essential characters. In the same race very great differences may be noticed. In the Tahitians and the New Caledonians the head of the condyle is sometimes nearly triangular, with one of the sides of the triangle placed outwards, and one of the angles inwards. Lastly, may not age here again exercise an influence? I would say as much, from the great opening that the sigmoid *échancrure* presents. We see thus how many studies and comparisons should still be made before pronouncing on the real value of the peculiarities which the Abbeville jaw presents.

"Thanks to M. Lartet, I have been able to compare already this jaw with a median portion of the same bone, found by him in the rubbish (*déblais*) of the cavern of Aurignac, and with the body of the same bone discovered by M. de Vibray, in the cavern of Arcy. M. Pruner-Bey kindly joined M. Lartet in the comparative examination that we made of these precious remains. On all points we concurred in the same opinions.

"In the portions common to them all, these three bones presented slight differences, but also resemblances. Thus the canal or gutter I spoke of just now, was distinguished from that in the Aurignac jaw, as well as from that in the Arcy, inasmuch as it appeared perhaps a little more decided there than the former. . . .

"In respect to the Abbeville jaw, it appears to all three of us to be very probably that of an aged individual, and in any case, of small size, or approaching, at most, middle stature.

"I will add, that in this jaw there is absolutely nothing that supports the ideas entertained by some adventurous minds, who make out man to be descended from the ape by means of successive modifications. This jaw is somewhat more feeble than strong; altogether characteristic of man; and it has nothing of the *ferocious physiognomy*, if I may be permitted the expression, that is sometimes displayed in the same part of the skeleton in existing races.

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* Dr. Falconer came independently to the same conclusions.

"In conclusion, we may readily observe in the lower jaws of individuals of our own time differences as much, and more, marked than any of those which distinguish the Abbeville jaw from many of the jaws in the Museum collections. In other words, these differences, in every respect, are within the *limits of variation* in existing races."

At the opening meeting of the Anthropological Society, on the 22nd February last, Mr. Mackie commented in strong terms on the evidence of the geological human remains, pointing out that the Engis and other oldest fossil skulls indicated a higher grade of man than one would expect as a link of the human race with the gorilla; and that, moreover, the geological evidence, truly put, showed primitive man as an intellectual, though it might be as the flint-implements indicated, a very inexperienced and untutored being; whilst of the gorilla, which the transmutationists admit to be man's nearest link with the brutes, not a single fragment had been found. Stating, however, his belief in the unity of Creation, he said he thought that if the link between man and the inferior animals were ever traced, it would be found to be short and sudden—at most a thread-like line of strongly variable descent, rather than a general gradual improvement of any breed of apes, as is supposed by the Darwinian hypothesis of a transmutation of species.

It is to be regretted that the Society's report of this meeting, published in the Anthropological Journal, does not record what he said, but, in a short and incorrect paragraph, attributes words to him he never spoke.

It is not a little singular that within a month the evidence from the Abbeville gravels should add direct testimony to this opinion.

At the sitting of the Paris Academy, on the 18th ultimo, M. Milne-Edwards gave an account of the proceedings of the commission at Abbeville. The 'Institut' adds: "The jaw exhibited before the Academy, the flint-implements which accompanied it, have been truly found in the bed *called* diluvial, at Moulin-Quignon, near Abbeville. We purposely say, in the bed called diluvial, for although all controversy has ceased in respect to the discovery, many geologists, at the head of whom is M. Elie de Beaumont, contest the diluvial nature of the deposit in which the discovery has been made. M. Elie de Beaumont declared in a very explicit manner, after having heard the reports of M. Milne-Edwards and of M. de Quatrefages, that according to his opinion the deposit at Moulin-Quignon is not *Diluvium* but a deposit belonging to the formation which he designated a long time ago as the 'terrain meuble des pentes,' that is, a kind of *Post-Diluvium* formed not by marine nor fluviatile alluvia, but by simple weather-action, and much later, or posterior, to the alluvia known by the term Diluvium. The human jaw, the object of so much study, would lose, then, in losing its antiquity, a great part of the importance that it would have had if the deposit was indisputably recognized as being diluvial; for, according to M. Elie de Beaumont, it is a simple relic of the period known as the stone-age, and the antiquity of which does not go further back than 3000 or 4000 years." This idea, however, remains to be proved; or, at least, after Mr. Prestwich's account of the district, it is necessary should have the geological evidence put before us before we accept this conclusion.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society.—*April* 1.—The Rev. Dr. O. Heer, Professor of Botany in the University of Zurich; Signor P. Savi, Professor of Geology in the University of Pisa; Signor G. Ponzi, Professor of Comparative Anatomy and Physiology in the University of Rome; Dr. J. Leidy, Professor of Anatomy in the University of Pennsylvania; Il Marchese Pareto, of Genoa; and Professor A. Daubrée, of the Jardin des Plantes, Paris, were elected Foreign Correspondents.

The following communication was read:—"On recent Changes in the Delta of the Ganges." By James Fergusson, Esq., F.R.G.S.

Before describing the local phenomena of the Ganges, the author explained, first, the laws that govern the extent of the oscillations in reaches of rivers, either laterally or in the direction of their course; secondly, the causes operating to raise the banks of rivers flowing through very flat plains above the level of the country at a little distance from their margins; and lastly, the immense relative thickness of the early deposits in deltas over those of later periods, when the conditions of the river had come more nearly *in æquilibrium.*

Mr. Fergusson then proceeded to point out that in historical times the Brahmapootra and Ganges, on entering the plains of Bengal,—passing Goalparah and Rajmahal respectively,—ran originally to the sea in a nearly due north and south course, parallel to one another. This symmetry was first disturbed by the upheaval of the Modopore jungle, north of Dacca, by which the Brahmapootra was diverted in a south-eastern direction into the depression known as the Sylhet Jheels, which were the result of the upheaval just described. He then further explained how the river, having filled up these Jheels, had returned to its former bed within the limits of the present century.

The paper then described the effect this change had already produced in reopening the rivers of the western half of the delta, and showed that, if it were maintained, it would have the effect of so raising the eastern half as to restore the course of the two great rivers very nearly to the position they occupied before the disturbance above alluded to.

The next point adverted to was the gradual retrocession of all the mouths of the tributaries of the Ganges, in consequence of the tilting back of the plain, by the gradual rise of the deltaic plains.

Mr. Fergusson then stated that he conceived we had sufficient historical indications to show that within the last 5000 years the plain of Bengal has been nearly in the same condition that the valley at Assam now is,—a jungly swamp, with only a few habitable spots here and there on the banks of the larger rivers.

The last phenomenon alluded to was the "swatch of low ground" in the Bay of Bengal. This was ascribed to the action of the tides, which, being accelerated on either shore of the bay, acquired a rotatory motion at the sand-heads, and, meeting in the centre of the bay, scooped or swept out this depression in the centre, and by this action prevented the growth of the delta seaward to the extent that would otherwise take place.

April 22*nd*.—1. "On the Gneiss and other Azoic Rocks, and on the superjacent Palæozoic Formations of Bavaria and Bohemia." By Sir R. I. Murchison, K.C.B.

The recent important discovery by M. Gümbel of a representative, near Hof, of the primordial zone of the Silurian basin of Prague, induced the author to obtain some further particulars regarding the older rocks of Bavaria and Bohemia; and a large part of this communication referred to the sketch-map and section supplied to him by that gentleman.

One of Sir Roderick's principal objects in exploring this region was to convince himself, if possible, of the existence of a fundamental gneiss of as high antiquity as the Laurentian rocks of Canada and Scotland, and of the truth of M. Gümbel's view of the distinction of the gneiss into older and younger; but, after a survey of the whole district, he was unable to distinguish any order of superposition between its two members, the so-called younger gneiss, in one extensive tract near the Danube, dipping, according to M. Gümbel, under the older; and their variable strike rendered it as difficult to judge by that character as by their dip, its direction in some places being at right angles to what it is in others. For the present, therefore, though with the greatest respect for the labours of M. Gümbel, he considers the gneiss-rocks to constitute one great series, it being certain that the two varieties are not separated by any different intervening sediment, as in the north-west of Scotland.

A clear illustration of the whole ascending succession is afforded by the order of superposition exhibited in M. Gümbel's section from Hof to Selb, a distance of about seven or eight miles. Gneiss is there seen resting against granite, and passing up into mica-slate underlying concretionary, quartzose, chloritic masses, which form the base of the Urthonschiefer. This primary clay-slate is followed by quartzites and black roofing-slate, in the latter of which the fossils of the Silurian primordial zone of Barrande occur, and ultimately by other Silurian, Devonian, and Lower Carboniferous strata in conformable succession, the latter passing conformably upwards into mountain limestone, which is shown to be quite unconformable to the Upper Carboniferous of Germany. In the remaining north-west portion of the section the strata are repeated in inverted succession, having been dislocated by the intrusion of igneous rocks.

Sir Roderick next adverted to the question of the parallelism of the Silurian rocks of Bohemia with those of Britain, pointing out that the Austrian Geological Survey, whose new map he exhibited, had adopted, for this occasion only, the colours used by the Geological Survey of Great Britain; and he stated his belief that too close a parallelism between the subformations had been attempted, and that the parallelism of such large groups only as Lower and Upper Silurian, as proposed by Barrande, with a possible interpolation of "Middle Silurian," could be maintained.

The author then contrasted the absence of Devonian and Lower Carboniferous rocks, coupled with the full development of Lower and Upper Silurian life, in Bohemia with the fuller and unbroken succession in Bavaria. He concluded by observing that the conformable succession of strata in Bavaria and other tracts shows the existence of beds which bridge over the gaps, represented by unconformities, that occur in the British series; and pointedly adverted to the two facts, that the enormous thickness of clay-slate beneath the primordial zone, though unaltered over large areas, had afforded no vestiges of life, and that the transitional groups of strata uniting two great systems had not afforded in any country a link connecting one class of animals with another.

2. "Notice of a Section at Mocktree." By R. Lightbody, Esq.

The lower portion of this section was stated to exhibit the Aymestry limestone, with its characteristic honeycomb structure, and showing at its upper limit a basin-shaped depression containing beds of sandy clay deposited parallel to its sides, and unconformable to the Aymestry limestone, though at a little distance from the trough this unconformity disappears. These argillaceous beds contain Lower Ludlow fossils, though they overlie the Aymestry limestone; the author consequently proposes that the latter term should no longer be used as a separate subdivision. He also remarked that, in consequence of a fault bringing the Upper and Lower Ludlow beds against one another, without having altered their dip, many fossils have been stated to occur in the Upper Ludlow which really belong to the Lower.

The following specimens were exhibited:—

A specimen of *Calais Newboldii*, a new Octopod, from Mount Lebanon, by J. de C. Sowerby, Esq. Palatal Teeth of *Cochliodus*, from the Carboniferous limestone, by the Earl of Enniskillen.

May 6th.—1. "On the Brick-pit at Lexden, near Colchester." By the Rev. Osmond Fisher, M.A., F.G.S.; with a note on the *Coleoptera*, by T. V. Wollaston, Esq., F.L.S.

Lexden is a village about a mile west of Colchester, and is situated on a plateau on the south side of the Valley of the Colne. The brick-pit shows this table-land to consist of thick beds of gravel and sand, resting upon the London Clay, and containing at its southern extremity a talus of old gravel. This stratified gravel is overlaid by brick-earth and soil, and is believed by the author to be that which elsewhere underlies the Boulder-clay; and he states that between it and the brick-earth there is, in one locality, a layer of peat containing bones of *Elephas primigenius*, and the remains of many insects; the latter are considered by Mr. Wollaston to differ from British recent species, and to indicate a warmer climate than now obtains in the district.

2. "On the original nature and subsequent alteration of Mica Schist." By H. C. Sorby, Esq., F.R.S., F.G.S.

When ripples are formed whilst material is being deposited, there is a structure generated which the author has, in former papers, termed "ripple-drift," and which he now described. This structure he stated might frequently be seen in polished sections of clay-slates, and also, in a form modified through metamorphism, in many mica-schists. From a consideration of the facts revealed by an examination of those rocks, he concluded that mica-schist is of sedimentary origin, metamorphosed after deposition, and sometimes after the production of cleavage and other physical changes; and that the bands of different minerals represent the planes of original deposition.

3. "On the Fossil Corals of the West Indies."—Part I. By P. Martin Duncan, Esq., F.G.S.

The paucity of information concerning the Geology and Palæontology of the West Indies, and the deficiency of carefully described species of recent corals, were stated to have involved this subject in great obscurity. Dr. Duncan, however, remarked that the paper by Dr. Nugent, published more than forty years ago, showed the existence in Antigua of three consecutive Coral-formations, called by him (in ascending order)—1, the inclined strata; 2, the chert; 3, the marl.

After describing in detail the seventy species and varieties of Fossil Corals from the West Indian Islands which he had been able to determine, Dr. Duncan exhibited in the form of tables the relation which this fossil fauna bears to the existing fauna of the Caribbean Sea, and to that of the Pacific, South Sea, and Indian Ocean, showing that it is more nearly related to the latter than to the former. He also showed that it bears a closer relation to the European Miocene coral-fauna than to the recent West Indian; and he therefore considered it to be most probably of Miocene age. The author concluded by describing what he believed to be the chief features of the physical geography of the Miocene period, substituting a series of Archipelagos for the Atlantis of Professor Heer, and stating that the Pacific Ocean must have been at that period in immediate connection with the Caribbean Sea.

A portion of the skull of *Mastodon latidens*, from Perim Island, in the Gulf of Cambay, was exhibited by C. S. Mann, Esq.

Civil Engineers.—*March* 3.—"On the Perennial and Flood Waters of the Upper Thames," by the Rev. J. C. Clutterbuck, M.A.

The object of this communication was to draw attention to the nature of that portion of the watershed of the Thames comprising the oolitic district, and containing a computated area of 1500 square miles, situated between the range of chalk hills bounding the vales of Aylesbury and of White Horse, and the Cotswold Hills bounding the Vale of Evesham and the Valley of the Severn. It was shown that the Thames ran almost entirely over a clay-bed from its source, about four miles west of Cirencester, to its junction with the Thame stream, the limit of the district under consideration; and that it was the mere carrier of waters, whether perennial or flood, brought in by its tributaries, a description of which, in the order they joined the main river, was given. Those running from north to south and from north-west to south-east,—as the Churn, the Coln, the Leach, the Windrush, the Evenlode, and the Cherwell,—received their perennial waters from oolitic strata. Those flowing from south to north originated in the the chalk hills, from the escarpment of which they conveyed the back drainage, slightly augmented by that of the Upper Greensand, and then passed over the Gault and Kimmeridge clays, either to the main stream, as the Ray and the Cole, or as affluents of the Ock and the Thame, from which the principal supply was derived.

The geological condition of the source of the main stream was next noticed, and it was stated that the whole natural bed of the river, from Somerford Keynes to Sandford, below Oxford, was an excavation in the Oxford clay, flanked to the south by the escarpment of the coraline oolite, which rested on a ridge of the clay. As a rule, the lower levels of the valley, including also in many places the oolitic rock, outcropping to the north at a very slight angle beneath the Oxford clay, were covered with drift gravel. Wherever the floods had extended, sand, silt, or argillaceous loam had been deposited on this gravel; and this action was still going on, governed by the number and character of the floods. Thus, the bed of the river was, as a rule, gravel, and the banks a warp, the accumulation of ages. There were instances of the change of bed to the extent of several chains in width; and indeed there appeared to be no limit to these deviations, but the physical features of the valley. These facts had an important bearing on any improvement, so much needed, in the drainage or condition of the Thames valley.

The perennial waters were either used for mills or for navigation. The mills on the tributaries were numerous. Between Thames Head and Cricklade they were, however, virtually deprived of water. From Cricklade to Lechlade the water was not applied to any economical use; and again, from Lechlade to Wolvercote, three miles above Oxford, there were no mills. The gaugings of the numerous tributaries, where they joined the main stream, would give the aggregate of the water that it carried; but such observations had been neglected, and as the watersheds were very varied, any estimate of the volume of these streams at different seasons would be difficult. Most of these tributaries were immediately affected by heavy rains, and were subject to flood. The gauging of the main stream was beset with other difficulties, as the height and passage of the water was divided between the mills and the navigation, controlled, indeed, by stringent regulations, but too often disregarded. Though it was not the purpose of this communication to deal with absolute quantities derived from the various sources, yet it was believed the following gaugings, the result of several years' observations, by Mr. Stacy, the manager of the mills at Wolvercote, would be received with interest, and would, if carried out in other places, lead to valuable results. There were no mills for thirty miles above Wolvercote, and the navigation, though "flashes" were still sent down, had virtually ceased. Mr. Stacy had found that, in the summer months, the river had a mean velocity of 58 feet per minute, when the total yield was 8120 cubic feet per minute, exclusive of the quantity brought down by "flashes," which it was difficult to estimate. During the winter months, in fine weather, without frost or rain, the river had a mean velocity of 94·9 feet per minute, and taking the sectional area as 181·5 square feet, this gave a volume of 17,224 cubic feet per minute. In moderate rainy weather, without floods, when the level of the river just reached the high-water navigation mark, the total quantity of water passing through the mill was 28,189 cubic feet per minute. At the end of December, 1862, under similar conditions, the total yield was 35,498 cubic feet per minute, of which 7738 cubic feet might be taken as the water passing from the main stream to Wytham. These data suggested the necessity of adopting a standard at various stations, so that the results might be compared with the rainfall when the gaugings were taken. At the same time, observations were made on the river below the influx of the Cherwell and the Ock, when the yield was found to be 50,995 cubic feet per minute, being an excess of 15,497 cubic feet as compared with Wolvercote, and of which excess it was estimated that 7689 cubic feet were brought in by the Cherwell, and the remainder by the Ock and the smaller perennial streams. The verification of these quantities was prevented by a fall of rain of nearly half an inch, in a few hours, which, at the expiration of thirty-six hours, doubled the volume of the Thame stream, and added about thirty per cent. to the volume of the main river. At Wolvercote, on the 5th of January, 1863, after about one inch of rain, the increase was from 27,986 to 48,418 cubic feet per minute. The rainfall from the 1st to the 7th January, 1863, inclusive, produced a flood in the Thames under circumstances peculiarly favourable for observation. The rain recorded during this period averaged 1·61 inch over the whole watershed; Dalton's gauge, at Hemel Hempstead, showing a fall of 1·52 inch, and a percolation of 1·10 inch. The gaugings of the main river at Wolvercote then amounted to 82,500 cubic feet per minute, and at Clifton Hampden, below Abingdon, to 181,832 cubic feet per minute. Of this latter quantity 44,755 cubic feet were delivered by the Cherwell (or an increase of 37,066 cubic feet as due to the flood), 24,864 cubic feet by the Ock, and 29,713 cubic feet by the many smaller streams, watercourses, and land-drainage outfalls, issuing into the river between Wolvercote and Clifton Hampden, a distance of about twenty miles by the river, with an average fall of two feet per mile, from a computed watershed of eighty square miles. It should be stated that the rainfall on this occasion, on the southern part of the district, was in excess of the average more than half an inch.

The state of the navigation between Lechlade and Oxford was then described. It was remarked that from running on one stratum, the Oxford clay, and from other causes, it had ceased to be; although the physical condition of the river bed, and its easy gradients, offered facilities for navigation; for the whole fall in this distance, 31 miles, was only 51 feet 3 inches, or about 1 foot 7½ inches on an average per mile.

The highest recorded floods on the Thames, since January 8, 1734, were then alluded to, and details were given of that which occurred March 29–31, 1862. The action of land-drainage on flood-water was next considered. It was generally admitted that the floods in the main river and its tributaries rose more rapidly than formerly; there being in some localities an advance of twenty-four in seventy-two hours within the last twenty years. There was a difference of opinion as to the subsidence of the water. As yet, however, it was believed, that land-drainage had produced little apparent practical effect on the volume of the flood, or perennial waters of the Upper Thames.

There was great scope for improvement in the valleys of the Thames and its tributaries, especially the Thame, the Ock, the Cherwell, and the Evenlode. With a view to prevent injury by floods, Mr. Bryan Wood had successfully carried out several important works, based on a system in which the local drainage was separated from the flood. If, by some such plan, the floods were brought under control, and the water prevented from remaining stagnant on the land, property would be improved, and the sanitary condition of the Valley of the Upper Thames would be greatly benefited.

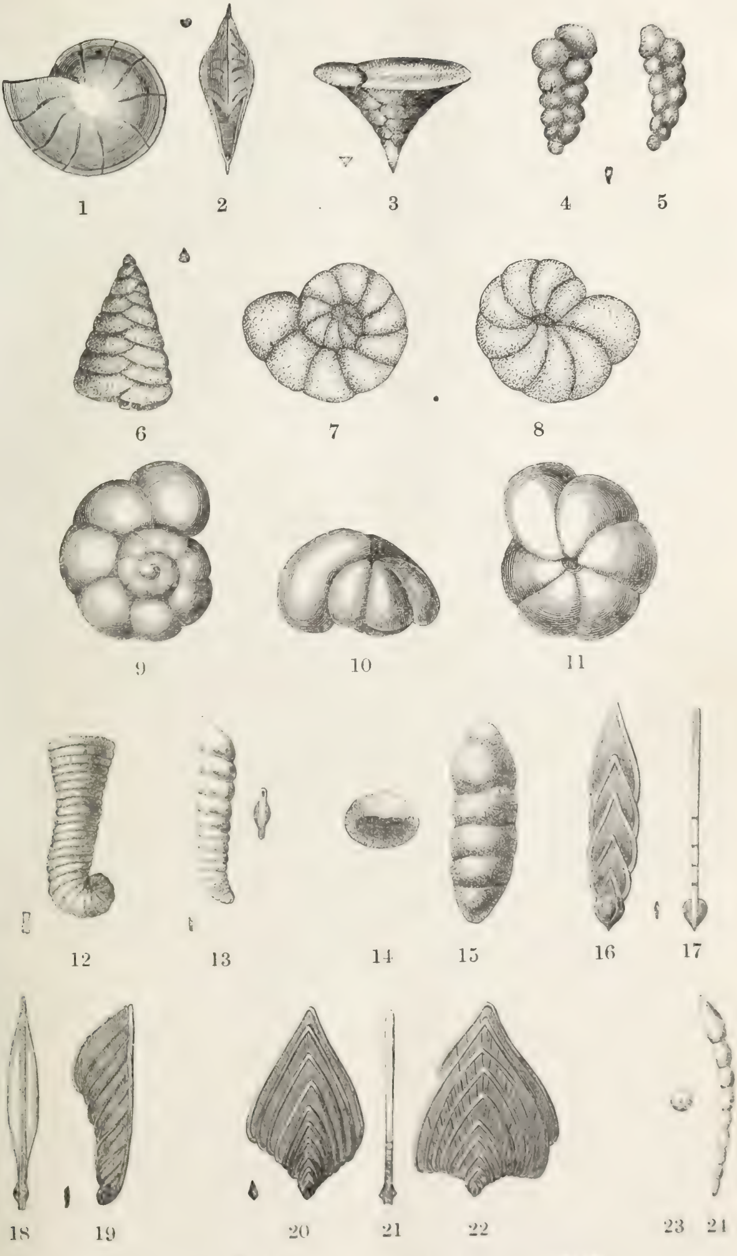
NOTES AND QUERIES.

Foraminifera of the Chalk.—At one time I paid considerable attention to the microscopic organisms of the Chalk, and those met with on the bands of flint-nodules, with the hope that I might be able to distinguish the various strata of the Upper Cretaceous deposits by this means. I cannot say the result was as successful as I could have wished. The white and grey chalks seemed characterized by sufficiently marked distinctions, but the main object I had in view was, if possible, to be able to distinguish one stratum of white chalk from another. Along a wide expanse of cliff, like that of Dover, Brighton, or Flamborough Head, it is easy enough, or rather it is practicable, to make out each bed definitely; but in collecting fossils from inland quarries, it is not so easy, and in fact is very often impracticable to make out the exact stratum exposed. It occurred to me then that microscopic characters might aid towards a conclusion, if they would not positively decide; and still entertaining this view, although to a greatly modified extent, I should be glad to learn the results of any microscopic investigations which any of the numerous readers of this magazine may have made.—Ed. Geol.

Deptford Gravel.—The low-level sewer now in course of construction at Deptford is excavated between the creek and the main street, in a deep bed of gravel, the spoil of which is now lying in heaps favourable for investigation. No worked flints have turned up. Fragments of elephant's tooth, and a whole tooth of rhinoceros (?) are the whole of the foreign contents, with the exception of some broken pottery of modern origin, and the singular occurrence of a few copper coins lying in apparently undisturbed gravel 35 feet from the surface. The gravel abounds in the usual flint fossils, and some fragments of the lower beds underneath have been extracted, consisting of compact green sandy marl. The highly intelligent manager of the works showed me the small museum of these curiosities in the counting-house of the works.—S. R. P.

[Halfpence are by no means reliable evidence; they are singularly enough found in many singular places. Workmen leaving their jackets whilst at work is a common source of their being lost about. It would be well for our contributor to state whether he saw these halfpence actually embedded, or only heard so; also, what their dates. If they fell out of workmen's clothes, as we presume they must have done, it is not at all

PLATE XV.



FORAMINIFERA FROM THE CHALK OF KENT.

S. J. Mackie del.

[illegible]

improbable they might be arrested and held in a chink or cavity in the gravel. As our correspondent's notice now reads, he would seem to state they were solidly embedded in the matrix of the gravel at a depth of thirty-five feet, a by no means likely occurrence.—Ed. Geol.]

Production of Copper.—The following extracts are from the 'Lake Superior Miner:'—

"In 1830, the total production of the copper mines of the world was about 25,500 tons of metal, and of this amount Great Britain produced 13,200, or more than 50 per cent. of the whole, while the United States and Canada furnished but 50 tons, or two-tenths of 1 per cent. The Russian Empire then produced nearly 4000 tons, the Austrian Empire 2150 tons, the whole of Asia some 2500 tons. In 1853, twenty-three years later, Britain had only increased her annual product to 14,500 tons, her percentage of the whole amount receding to 26; while Chili, in South America, which in 1830 only yielded 200 tons, had raised her product to 14,000 tons, or over 25 per cent. of the total production, From that period forward to the present time, the copper production of the Chilian mines we believe, exceeded those of any other country, the value of their exports in that metal alone amounting to $10,760,000 in 1857, while the value of British mine products for the same year was worth about $9,500,000. The Russians had increased the yield of their mines to 6,500 tons, or 11¾ per cent. of the whole; the Austrians to 3300 tons, or 6 per cent.; the whole of Asia only 3000 tons, or 5½ per cent.; while the United States and Canadas raised that year 2000 tons, over 3½ per cent. of the total products for that year, which were about 55,700 tons; Australia and New Zealand produced about 3000 tons; Cuba, 350 tons; Scandinavia, 2000 tons; the German States, 1450 tons; and the rest of Europe, exclusive of the countries above named, 1000 tons.

"During the past ten years, the mines of Lake Superior have probably increased their production more rapidly than those of any other country, the exports for 1861—7500 tons of metal—being about twelve times greater than those of 1851. That our ratio of increase in the coming ten years will be as great should not probably be expected, as that would amount to 90,000 tons; more by at least 40 per cent. than the present product of the world's mines, Of the 80 miles of copper range east of us, and 40 to 50 miles west, comparatively few mining properties have yet been explored."

Usefulness of Diamonds.—Many persons suppose that diamonds are only used as jewellery,—for rings and other articles of personal adornment,—and that they are really of no essential value whatever in the practical arts. This is a mistaken notion; they are used for a great number of purposes in the arts. Thus, for cutting the glass of our windows into proper sizes, no other substance can equal it, and it is exclusively used for this purpose. A natural edge, or point, as it is called, is used for this work, and thousands are annually required in our glass factories. Diamond-points are also employed for engraving on carnelians, amethysts, and other brilliants, and for the finer cuttings on cameos and seals. Being very hard, the diamond it also used in chronometers for the steps of pivots; and as it possesses high refractive power and little longitudinal aberration, it has been successfully employed for the small deep lenses of single microscopes. The magnifying power of the diamond in proportion to that of plate glass, ground to a similar form, is as eight to three. For drawing minute lines on hard steel and glass, to make micrometers, there is no substitute for the diamond point. The rough diamond is called "bort," and the "points" used for glass cutting are fragments of the borts. Great care and skill are necessary in selecting the cutting-points, because the diamond that cuts the glass most successfully has the cutting-edges of the crystal placed at right angles to each other, and passing through a point of intersection made by crossing the edges. A polished diamond, however perfect may be its edges, when pressed upon the surface of the glass, splinters it with the slightest of pressure; but with the natural diamond the most accurate lines are produced on glass, and their surfaces are so finely burnished that if, ruled close together, they decompose light and afford the most beautiful prismatic effect, —all the colours of the rainbow flash from them as from the silvery interior of a pearl-oyster shell. Diamonds are also employed as drill-points to perforate rubies, and bore holes in draw-plates for fine wire, and also for drilling in hard steel. Some inquiries have been made recently in regard to using them as a substitute for steel picks in dressing millstones. We apprehend that they are altogether too expensive for this purpose at present; but if some of our inventors would make the discovery of manufacturing diamonds as cheaply as we make charcoal, which is of the same composition, we might be able to recommend them to our millers. The coke obtained from the interior of gas retorts, in many cases, is found so hard that it will cut glass; but as its point endures but for a short period, it cannot be made available as a substitute for the natural diamond for such purposes in the arts. A circle of rough diamonds has lately been used on a hollow cylindrical auger for boring into hard rocks.

MAMMALIAN REMAINS.—Bones of the following Mammalia were recorded by M. Torchi in a letter read before the French Geological Society, 6th April, 1846 (Bull. Géol. Soc. Fr. vol. iii. p. 440–442), found in different strata of the sub-Apennine deposit at Imola, in Romania. *Elephant* found at Ruisseau de Bergullo in "sable quarzeuso-calcaire conchylifère" (marine shells); *Elephas primigenius*, Ruisseau Pratella, in "terrain quarzeuso-calcaire; *Elephant*, Vallée delle Grazie, Ruisseau Pratella, Ruisseau Bergullo, in the same sand; *Rhinoceros*, Ruisseau Pratella, in the same sand; *Hippopotamus*, Ruisseau Pratella, Ruisseau delle Grazie, in the "dernière assise de la Marne fleuve," sub-Apennine; *Equus*, Ruisseau Pratella; *Cervus*, Mont Castellano, Ruisseau Pratella, Fleuve Santerno, in the sand; *Ruminant; Volatile*, Ruisseau de Goccianello, Ruisseau Pratella, in the sand.—S. J. M.

NEBRASKA SALT BASINS.—About 50 miles west of the Missouri river there is a remarkable salt region covering about 1500 acres. It consists of four basins depressed several feet below the common level. The bottoms of the basins are composed of black mud covered over in warm dry weather with a thin stratum of salt, causing them to look like fields of snow. The salt is collected in scrapers, and occasionally a man will scrape up a waggon-load a day. In and about all those basins there are numerous strong brine springs, and farmers come from miles around to boil and scrape salt for their use. It is of excellent quality, and the crystals are large and clear, like those of the solar salt of Syracuse, New York.

NUTS OF CORYLACEÆ, ISLE OF WIGHT.—In the 'Enumeratio Rerum Naturalium quæ in Musæo Zannichelliano asservantur,' Venetiis, 1736, is the following entry:—

"Tabula quinta. 14. Nuces Corylaceæ effossæ in insula Vecti, Angliæ."

The same entry occurs also in the earlier catalogue of Zannichelli's collection, entitled 'Ex Naturæ Gazophylacio penes Joannem Hieronymum Zannichelli.' Venetiis, 1726.—S. J. MACKIE.

REVIEWS.

The Physical Geology and Geography of Great Britain. By Professor A. C. Ramsay, F.R.S. London: Stanford. 1863.

This little book, by the Local Director of the Geological Survey of Great Britain, and President of the Geological Society of London, is founded on a course of six lectures that were delivered to working men in the Museum of Practical Geology in January and February of this year, and seemingly published immediately after their close. This would lead one to suspect they were intended to be the vehicle of some special views at a particular moment, just as Professor Huxley has turned his similar lectures to a purpose suited to the advance of his school. Such, however, we cannot make out to be the case, unless the object of Professor Ramsay was to make an opportunity for asserting that having handled stones for five-and-twenty years, he knew a chipped flint when he saw it (p. 111). Unless this is so, or we have in our obtuseness missed the points of prominent novelty, the three little letters which represent the commercial value of all labours would appear to be the motive for sending out to the world lectures of the most elementary character.

They open pleasantly enough with a reference to the good old days, when those who thought upon the matter at all were content to accept the world as it is, and to believe it always was so. The inquisitiveness of the present age has made man, however, a more restless animal than he was a century ago, and instead of being a kind of perambulating vegetable in a limited locality, he travels by pent-up clouds with the speed of the hurricane, and writes letters and draws portraits with lightning a hundred miles away. Men are not now content to take things as they are, but are intent on knowing what they have come from. Even the working man takes an interest in knowing the history of the soil his spade turns over, and the rock his pick brings down. The lime-burner finds shells in his chalk, and asks how they got there; the road-mender sees fish-scales and sponges in his flints, and inquires what was their origin. "Experience tells us," says Professor Ramsay, "that at these courses of lectures a number of my friends come to see me again and again, and that also there are many new faces present;" and for this reason he finds it necessary, while bound to teach the rudiments of our science, to vary his subjects as much as possible.

The first lecture is on Classification and Denudation; the second on the Physical Structure of Scotland, chiefly dealing with contortion of strata and metamorphism. In it the author tells the old story of a red-hot globe, and a boiling sea, and a primitive crust of granite, in a manner worthy of a Plutonist a hundred years ago, and then admits that subsequent research has shown that this theory will not hold, for, amongst other reasons, there are gneissic rocks of almost all ages in the geological scale. Abandoning then the terms 'igneous' and 'primitive' for granitic and gneissic rocks, and retaining the term 'primary,' is there not an inconsistency? Still more, is not the abandoning the term 'igneous' a fatal concession for the internal heat and gradual cooling down doctrines to which geologists, and the Professor amongst them, still cling like drowning men to straws? Nor is Professor Ramsay's explanation very intelligible or very logical, to our mind. "Now," says he, "I must briefly endeavour to give you an idea of the theory of metamorphism. The simplest kind is of the nature which I hinted at in the last lecture, namely, when an igneous comes into contact with a stratified rock, and when having remained for a long time in a melted state, an alteration in the stratified rock in immediate contact with it takes place." Now rocks do not meet as friends do in walking about the earth, the superior and subjacent rock must, we apprehend, be in immediate contact, at any rate since the first deposit of the latter; and therefore if granite be an igneous rock or fire-heated rock, must not the sedimentary rock have been deposited originally upon it, if it be right to say one rock of one kind of formation is changed by coming into contact with another rock of another kind of formation? We know, of course, the popular notions, but we expect from a geologist in Professor Ramsay's position something more than a parrot-like repetition of popular notions. Such a book as the present, however admirable it may be as an elementary introduction to a deep and attractive science,—and this merit we freely and willingly accord it,—would be unworthy of the author, and his rank as a geologist, and his standing in society, unless it were the vehicle of higher instruction than could be given by a college youth fresh from his class. Elementary treatises we do not expect—unless of more voluminous character, like Lyell's, Delabeche's, Phillips's, or Mantell's—from a *savant* of eminence; and such small essays as the present are rather the class to expect from young men coming into notoriety than those older men who have acquired fame, and from whom we expect, especially when they are in the national service, higher and far more responsible works. Why time should not permit the Professor from showing *how* heat "sometimes eats (*sic*) its way towards the surface in a manner not immediately connected with volcanic action;" why, for his own part, he should believe, and yet leave unexplained his belief, that in one sense granite is an igneous, and in another sense a metamorphic rock; why fusion by heat is necessary for the softening of the rock and the movements of the constituent particles in the act of crystallization; why he should forbear at present from entering on the theory of the essential presence of highly heated water in the formation of granite, as being foreign to the object of his lecture,—are matters of regret, for their subjects are points of very great interest, and properly dealt with would have given high charms to this rudimentary production. But he has preferred to hide his light under a bushel, and to leave the world in darkness. Altogether, metamorphism is, to our minds, so treated with such a want of logic, and such a muddle of facts, and forgetfulness or neglect of recent researches, that it would have been far better for geological science, if not for the author's reputation, that this portion had been eliminated. The third lecture is on the Physical Structure of England, and deals concisely with the various stratified formations, taking up, amongst other topics, the relationship between disturbance and form of country, the effects of disturbance, and denudation. The fourth treats of the distribution of the Miocene and Pliocene Tertiary Strata, Glacial Phenomena, and Origin of certain Lakes, —the glacial epoch, illustrated by glacier and other existing ice phenomena, being treated in a remarkably simple and explanatory manner, and thoroughly worthy of any writer; indeed this portion possesses a charming clearness and enthusiasm rarely equalled. The fifth lecture deals still with the newer or Pliocene strata, treating of the denudation of the coasts of Britain, the present British climates and their causes, areas of drainage, river-valleys and their origin, old river-gravels and prehistoric human remains, historical elevation of the country. Upon this latter subject we have also a word of comment to make. It is very easy for geologists to say "heave up the land," but it is as yet rather doubtful whether nature is quite so ready or able to *do it* as geologists are to *suppose* it done to get difficulties out of their way. It is quite possible that many of the so-called "heaves up" of the land may have other explanations than any heaving at all; and without wishing to say there is no such thing as an elevation of the land, we would certainly ask geologists to bear in mind the possibility of there being variations in the level of the sea. The slow change in the direction of the polar axis, and the possibility of alterations of the axis itself, suggest at least two causes which might effect very considerable differences in the bulging of the sphere of waters round our globe; and some such natural and recurring changes as would be thus brought about, seem more likely than so many jumpings up and down of that solid land, which at any rate appears to be very steady just now. Then, what Mr. Geikie, who is referred to on the point, considers as evidence of upheaval within the historical period, Mr. Carruthers looks upon in a very different light.

The sixth and concluding lecture has for its subject the special effects of the Physical Geology of the country on population and industry, a subject of general interest, and although briefly yet clearly treated, the concluding paragraphs deserve quotation.

"It is interesting to go back a little and inquire what may have been the condition of our country when man first set foot upon its surface. We know that these islands of ours have been frequently united to the Continent, and as frequently disunited, partly by elevations and depressions of the land, and to a great extent also by denudations. When the earliest human population reached their plains, they were probably united to the Continent. Such is the deliberate opinion of some of our best geologists. They do not assert it as a positive fact, but they consider it probable that these old prehistoric men inhabited our country along with the great hairy mammoth, the rhinoceros, the cave-bear, the lion, and the hippopotamus; that they travelled westwards from the continent of Europe, along with these extinct mammalia, over that continuation of the land which originally united Great Britain to the Continent. But in later times denudations and alterations of level have taken place, chiefly, I believe, great denudations of the chalk, and of the strata that cover the chalk, and then our island has become disunited from the mainland. And now, with all its numerous inlets, its great extent of coast, its admirable harbours, our country lies within the direct influence of the Gulf stream, which influences the whole climate of the west of Europe; and we, a mixed race of people, Celt, Scandinavian, Saxon, Norman, more or less intermingled in blood, are so happily placed that, in a great measure, we have the command of the commerce of Europe, and send out our fleets of merchandise from every port. We are happy, in my opinion, above all things in this, that by denudation we have been dissevered from the continent of Europe, for thus it happens that, uninfluenced by the immediate contact of hostile countries, and almost unbiassed by the influence of peoples of foreign blood, during the long course of years in which our country has never seen the foot of an invader, we have been enabled so to develope our own ideas of right and wrong, of political freedom and of political morality, that we now stand here, the freest country on the face of the globe, enjoying our privileges under the strongest and freest Government in the living world."

In the objections we have made to certain topics, we have not wished those objections to stand against the book. They hold, one might say, equally against any other popular book on science at the present time, and rather against geologists generally than books at all. 'The Physical Geology and Geography of Great Britain' is a little book deserving of more than one edition, and will be deserving of very many when Professor Ramsay gives his mind to the two points we have criticized, especially the first, and rewrites those portions. It will be then a work that will deserve a wide range. We hope to see this done, and Mr. Stanford realize a goodly return from many successive publications.

The Great Stone Book of Nature. By D. T. Ansted, M.A., F.R.S., F.G.S. London and Cambridge: Macmillan and Co. 1863.

The 'Great Stone Book of Nature' would perhaps have been better called the pretty little book of Geology. What's in a name, indeed? and what's in a title, so long as the owner of the one and the contents of the other are good? We have just reviewed one good little book, and here is another. Great men nowadays seem given to little things; and, truly, from such small seed sown broadcast, we may expect to reap a good crop when the seed shall have ripened to harvest in the next generation. Prettily Mr. Ansted opens his pretty book. "All know what is meant by the Book of Nature. But nature is rather a library than a book; for it is the general and well-stored receptacle of all that has ever been created, of all we know and all we have not yet learned, of all that is animate and all that is inanimate, of all that is happening and all that has happened, not only on the earth, but above the earth, and within it and around it. Nothing once existing has entirely disappeared. Everything has been photographed and is preserved for use and reference somewhere and somehow. Every year something is discovered that was not before known; but there remains so vast an amount of material yet unknown and unrecorded, that we may be quite sure it will never be exhausted, however long the human race may remain on the earth, or however highly the faculties of man may be developed." In the river-bed and sea-beach, in the sun, wind, rain, and frost, Mr. Ansted finds the key to the language of the great stone book of the world; he then opens its leaves and shows us the stones of the great stone book. Then he points out the placements and displacements of the stones of the great book, in the brick-pit and gravel-pit, in the quarry, the mine, by volcanos and earthquakes and other disturbances of rocks. Now come the pictures of this great stone book—wonderful pictures, too, they are. Next the treasures,—gems rich and rare, metals precious,—the more really precious the more useful. And so through his brief narration of the world's own special wonders, we are brought to the end of his pretty little book that prettily tells the great story of the Great Stone Book. And Mr. Ansted shuts up his little book, teaching the lesson our young friends will ever learn by an earnest study of the great book itself. "We may never in this life succeed in discovering the whole plan, for it is not likely that finite powers can grasp the Infinite design. But each endeavour that is made humbly and honestly will be productive of good, and the student will rise from the study of any part, either of the work or the method, with wider and clearer views, and be better fitted to perform his other duties and be useful to his fellow-men."

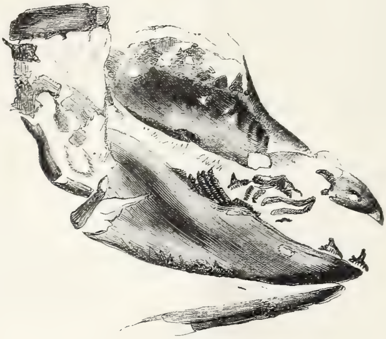


Fig. 1.

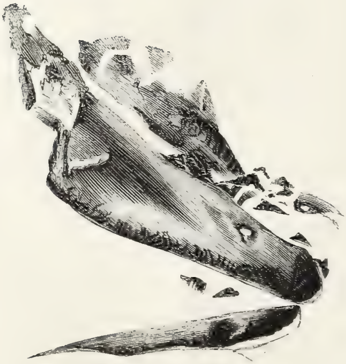


Fig. 2.

HYBODUS DUBRISIENSIS, n.s., Mackie.

From the Lower Chalk of Dover (Kent), nat. size.

[In the National Collection, British Museum.]

Fig. 1. Side View. Fig. 2. Base of Lower Jaw, seen from above.

S. J. Mackie del.

THE GEOLOGIST.

JULY 1863.

ON A NEW SPECIES OF HYBODUS FROM THE LOWER CHALK.

By S. J. Mackie, F.G.S.

Since the publication of Agassiz' 'Poissons Fossiles' only one addition, that we are aware of, has been made to our knowledge of this interesting genus of fishes,—certainly, at least, in respect to British geology. In 1845 Sir Philip Egerton described, before the Geological Society, a large jaw, or rather mouth of teeth, of a fish of this kind, found by Captain Ibbetson in the Isle of Wight, and named by Sir Philip *Hybodus bassanus.*

This species has been assigned to the Lower Greensand, in Morris's Catalogue, but the bed seems, from Sir Philip's statement, to be in a dubious position, for he speaks of it only as "near the junction of the Lower Greensand and Wealden," and says the specimen was sent to him "in the hopes it might tend to show to which of the two formations its bed should be assigned,"—a question he further declines to answer, as "the evidence it affords on this question is neither direct nor conclusive, inasmuch as it is an undescribed species; and consequently any deductions beyond those based upon general affinities would be unwarrantable." Sir Philip adds, however, further on: "The geological inferences afforded by the specimen are briefly told. The species is new. The genus is undoubtedly Hybodus. This genus attains its maximum expansion in the Oolitic series, but it ranges from the Muschelkalk to the Chalk inclusive. The only evidence of its occurrence in the latter formation is a fragment of an ichthyodorulite in the Mantell collection. The teeth have not been found in any strata more recent than the Wealden. As far, therefore, as the evidence goes, it seems much more likely to be of an age anterior to the Cretaceous system." This, then, is at most only doubtfully a Cretaceous species; and the only other instance of which we have any published figure or description is the *Hybodus sulcatus* referred to by Sir Philip, and recorded in Morris's "Catalogue," on the authority of Agassiz (vol. iii. p. 44, t. 106, fig. 15, 16), as from the chalk of Lewes in Sussex. All Agassiz says is, "M. Mantell possesses two fragments of rays of a Hybodus found in the chalk of Lewes, but which are in a bad state of preservation. One recognizes, however, on the surface the furrows and the longitudinal ridges, characteristic of *Hybodus*, which present this particularity, that they are very straight (*droites*) and very uniform. At the posterior edge one distinguishes a well-marked longitudinal ridge (fig. 16*a*), which constitutes a specific character sufficiently defined to permit the founding of a species upon such imperfect pieces. I have not seen any teeth on the posterior sides; I doubt not, however, that such existed, but they have probably been broken, which does not appear astonishing in fragments so damaged." These two fragments, little more than an inch each in length, are now in the British Museum; and a careful inspection has convinced me that grains of Wealden grit still adhere to them, and, therefore, that they can no longer be regarded as even Cretaceous still less as Chalk specimens. No Chalk fossils were ever seen of such a peculiar nature as the substance of which they are composed. There remain, then, to retain *Hybodus* as a Cretaceous species, only those relics, whatever they are, which Professor Morris has recorded as "species: Chalk, Northfleet (Collection Wetherell); Norfolk (*Rose*)," and which have never yet been figured nor described.*

Very great interest, therefore, attached itself at once to a small but very fine and delicately-preserved jaw, with numerous teeth, to which my attention was drawn, in the National Collection (No. 36908). It is from the Lower Chalk of Dover. The extreme length of the right ramus of the lower jaw is 2¼ inches; its vertical depth at the middle and deepest part, ⅝ of an inch; and the depth of the upper and lower jaws together, 1¼ inch. There are twenty-five teeth in all, fully visible, and fragments may be detected of one or two more.

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* Mr. Rose informs me that the reference in Morris's Catalogue is to a specimen in his collection identical with the ichthyodorulite figured in Dixon's 'Geology of Sussex,' tab. xxxii. fig. 7, which, however, is not Hybodus. Mr. Rose's specimen is from the Lower Hard Chalk of Whittington, near Stoke Ferry, West Norfolk. What the specimens in Mr. Wetherell's collection are we do not know.—S. J. M.

In all these teeth the central tubercle is much elongated, and in the front teeth assumes a regular tooth-like form, with a less expanded base, apparently only about equal in length to the height of the principal central tubercle. As, however, the teeth recede towards the angle of the jaw, the central tubercle becomes more and more depressed and the base more and more expanded; the central tubercle at last becoming very little elevated, and the lateral denticles very numerous, but with elevations gradually lessening towards the outer ends of the base, in the invariable manner of the teeth of *Hybodus*, and which to us forms the distinguishing feature of the teeth of that genus from the teeth of species of *Cladodus*, in which, on the contrary, the denticles increase in size as they recede from the central tubercle. In all else the two genera seem very closely similar. The teeth of *Acrodus* are also very close in their characters.

In these remarks, it will be seen that we differ from Sir Philip Egerton as to the general uniformity of the teeth of *Hybodus*, and which, on the contrary, we believe varied, as sharks' teeth are well known to do, according to their positions in the jaw. In the specimen we are noticing, from the grey chalk of, probably, Abbot's Cliff, between Dover and Folkestone, this is very prettily shown; and the little group of four or five back teeth (seen in our Fig. 1, Pl. XIII.) exhibit this feature in a remarkable and exquisite manner.

We are inclined, too, to raise a question as to the range in geological time of the genus, at least within the British area. *Hybodus* seems to us to make its first appearance, and in quantity, in the Lias bone-bed. In Morris's "Catalogue" *H. læviusculus*, *H. minor*, and *H. plicatilis* are all referred, with a query, to the Trias,—the first coming from Aust Cliff, the second having the localities Aust and Axmouth, and the last that of Axmouth, recorded, seemingly, on the verbal statement of Sir Philip Egerton. The *H. keuperianus*, entered as from the Keuper of Worcestershire, is evidently the spine of Nemacanthus, an Aust Cliff bone-bed fish.

Of the first, *H. læviusculus*, however, Agassiz, who described it, mentions it as "a very little fragment of a ray of this species in the Museum of Bristol, coming from the Lias of Aust Cliff." Of the second also, he says, "The rays designated under the name of *H. minor*, are really only found in the Lias of the environs of Bristol at Aust Cliff, where we do not find great rays as at Lyme Regis, and they are accompanied in this locality by a kind of teeth very different from those of Dorsetshire." The Muschelkalk, *Hybodus plicatilis*, Agassiz founded on teeth collected by M. d'Alberti from Tæbingen, and some by M. Bronn, from Schwenningen, in Würtemberg. In his notice of this species, Agassiz seems to have imbibed the idea, which Sir Philip Egerton has followed, of there being a great uniformity in the teeth of Hybodus, and upon these grounds excludes from the figures 7 to 18 of Plate 24, which he had assigned to *H. plicatilis,* all but fig. 10 and 13; raising 7, 8, 11, 12, 14, 16, into the species *H. Mougeoti,* and fig. 17 and 18 into *H. polycyphus*, and fig. 9 and 15 into *H. angustus.* These three species, however, unless they have something more definite besides this untenable character of non-variation to depend upon, must hereafter be looked upon as very questionable, as the variation of the teeth in our Chalk specimen must render evident to every unbiassed mind.

The question of the geological age of *H. plicatilis,* must rest on the correctness of the assignment of the so-called Muschelkalk beds of Tæbingen and Schwenningen; but there are, it will be seen further on, other specimens in our National Collection from beds termed Muschelkalk in other Continental localities: and from which, too, *H. obliquus*, *H. rugosus*, and *H. sublævis* are recorded.

Agassiz is certainly wrong in admitting *H. sulcatus* at the recent end of the geological series as a Chalk specimen, and it would be well therefore to examine the right to the antiquity of those species he and others put at the older end of that series. I am not sufficiently acquainted with the Muschelkalk strata to do this myself.

Still, so nearly allied as is the genus *Acrodus*, we may expect, if we believe in development doctrines, a few early preceding forms in an era older than the Jurassic—the period of "reign," *par excellence*, in quantity of individuals and in number of species of the genus Hybodus. The teeth of our Chalk species—the most recent known—are more like those of the Muschelkalk species (*H. plicatilis*) than any other, and a comparison with fig. 1 of Agassiz' Plate 22*a* may well be made. This resemblance is not, perhaps, a little singular; and we have a floating idea—not yet properly worked out by facts—that during the period of extinction of a genus or family, there is a tendency to sportive (?) varieties, and amongst these a greater or less disposition to revert to the originating form. For example, in the Cretaceous era, when the Ammonites died out, we see numbers of forms, Hamites, Crioceras, etc., reverting, as it were, back to the primitive Orthoceras, until in the Baculite of the Upper Chalk, where the chambered-cephalopods—excepting the Nautilus—cease altogether, we have a form straight and conical as that primitive type itself. Perhaps, however, this is but a fanciful idea, and time will not now allow us to work it out.

The species given by Professor Morris are—

From the Chalk (error, should be Wealden, S. J. M.)—*H. sulcatus;* species, chalk, Northfleet (Wetherell Coll.), Norfolk (Rose Coll.) ; Lower Greensand (? Wealden, S. J. M.), —*H. basanus;* Wealden,—*H. subcarinatus;* Portland,—*H. strictus;* Kimmeridge Clay,—*H. acutus, H. leptodus;* Common to both Great Oolite and Wealden,—*H. dubius, H. dorsalis* (Hastings), *H. marginalis, H. striatulus;* Great Oolite,—*H. apicalis, H. grossoconus, H. Lawsoni, H. obtusus, H. polyprion, H. undulatus;* Inferior Oolite,—*H. crassus;* Lias,—*H. carinatus, H. crassiformis, H. curtus, H. Delabechei, H. ensatus, H. formosus, H. medius, H. pyramidalis, H. raricostatus, H. reticulatus;* Trias? (Lias Bone-bed, S. J. M.),—*H. lævinoculus, H. plicatilis, H. minor;* from the Keuper of Worcestershire,—*H. keuperianus.*

The following are the specimens of Hybodus in the British Museum:—Back tooth of *Hybodus polyprion*, Agassiz, from Wealden of Tilgate Forest (Mantell Coll.); back tooth of *Hybodus* (? sp.) from Wealden of Sussex (Dixon Coll.) ; several front teeth of *Hybodus* (? sp.) from Wealden, Tilgate Forest (Mantell Coll.) ; front teeth of *Hybodus grossiconus*, Agassiz; Wealden, Tilgate Forest (Dixon Coll.); others of same species, no locality given, but name of "P. Doran" attached to label; two others of same species from Forest Marble of Atford, collected by Mr. Wood; some from the Forest Marble of Stanton, presented by W. Cunnington, Esq. ; one from the Forest Marble of Malmesbury, collected by Mr. Buy; one seemingly of the same species from the Great Oolite of Stonesfield; several from the Forest Marble of Wiltshire (W. Cunnington, Esq.); two from Stonesfield Slate of Oxfordshire (Mantell Coll.), several from the Stonesfield Slate of Eyeford, collected by Mr. Binfield. Back teeth of *Hybodus polyprion*, from the Stonesfield Slate of Eyeford (Mr. Binfield); one from Great Oolite of Stonesfield, presented by S. P. Pratt, Esq.; one also apparently of the same species from the Great Oolite of the same locality; two from the Stonesfield Slate of Oxfordshire (Mantell Coll.) ; three anterior side-(?) teeth, seemingly of this species, from the same formation and district; a posterior (?) side-tooth from Great Oolite of Stonesfield; four largish teeth of a Hybodus, apparently *H. polyprion*, from the Great Oolite of Malton (Bean Collection). Two back teeth of *Hybodus reticulatus*, Agassiz, from the Lias of Lyme Regis; six of *Hybodus pyramidalis*, Agassiz, Lias, Lyme Regis; a very fine mass of jaw, and numerous teeth of *Hybodus reticulatus*, Lias, Lyme Regis; slab with numerous large and fine teeth of a species of Hybodus, Lias, Lyme Regis; very fine congeries of back teeth of a *Hybodus*, seemingly the same species as the last specimen, from the Lias of Lyme Regis, collected by J. Johnson, Esq.; two large wide-based teeth with prominent central tubercles, from Lias of Lyme Regis; very long-pointed broken tooth, Lias, Lyme Regis; small slab with thirteen teeth, and a solitary tooth of Ichthyosaurus, from Lias, Lyme Regis: a fine congeries of large strong teeth of *Hybodus pyramidalis*, collected by J. Johnson, Esq., from the Lias of Lyme Regis; two small masses of teeth, Lias, Lyme Regis (Mantell Coll.): two teeth of *H. reticulatus*, Lias, Lyme Regis: isolated back tooth of *H. pyramidalis*, Lias, Lyme Regis; five foreign broken teeth of same species, from the Lias of Ohmden, collected by M. P. Mohr; three teeth of *Hybodus*, collected by Mr. Buy, from the Oxford Clay of Christian Malford, Wiltshire; front tooth, Oxford Clay, Christian Malford; some foreign broken front teeth, from the Bone-bed of Crailsheim, collected by M. P. Mohr; single back tooth of *H. raricostatus*, labelled "Trias," Aust Cliff,—an assignment we doubt the correctness of. Several front teeth of *Hybodus minor*, Agassiz, from the Lias Bone-bed at Bristol; two foreign back teeth of *Hybodus plicatilis ?*, from the Muschelkalk (? S. J. M.) of Baireuth, collected by M. P. Mohr; other foreign teeth, assigned to the same species, from Muschelkalk (?) of Baireuth (Mohr and Dr. Braun), Halle (Mohr), Leineck (Dr. Braun), and *H. obliquus*, Baireuth, Leineck (Braun), (sp.?) Leineck (Braun); *H. longiconus ?*, Ag., from Bone-bed of Crailsheim (Mohr), *H. rugosus*, Pl., from Bone-bed of Crailsheim and Halle (Mohr), *H. sublævis*, Ag., from the Keuper of Würtemberg (Dr. Krantz), *H. cuspidatus* (Krantz), and an unassigned front tooth from the Keuper of Wurtemberg, collected by Dr. Krantz. There are also to be added to the British specimens a small fragment of the Aust Cliff rock, with teeth of *Hybodus*, and which fragment is referred on the tablet with a query to the "Trias." In addition to these are numerous fin-rays in the wall-case, No. 7, in the North Gallery, referred to various species, but for the present we reserve our remarks on these.

We regret we cannot go at greater length now into the investigation of this interesting genus. The specimen we have figured, however, is well worthy of accurate description, and on no finer one has any species of *Hybodus* yet been founded. I propose the specific name of *Dubrisiensis* for it, and will give in our next number a descriptive summary of distinguishing characters and enlarged figures of the minute teeth, which require more care and delicacy of drawing, and consequently time, than I can possibly at this moment give to them.

CRUSTACEAN TRACKS IN POTSDAM SANDSTONE.

The following interesting letter by Professor Hall (31st Oct. 1862), "On a New Crustacean, from the Potsdam Sandstone," was published in the December number of the 'Canadian Naturalist.'

I have been much interested in reading your observations upon the tracks of Limulus in sand, and comparisons with the tracks in the Potsdam Sandstone;* more especially as these observations connect themselves in a remarkable manner with a recent discovery of my own; and a question may arise as to whether you have described an animal which I have found, or I have found the animal corresponding to your description. I will leave you and the scientific world to judge of the facts. However, after what you have written, I cannot now publish what I communicated to the Albany Institute last winter, without referring to your paper; and in the meantime you may lay this note before the Montreal Natural History Society, and publish it, or such parts of it, as you please.

In February last, I communicated to the Albany Institute a notice of a new crustacean from the Potsdam Sandstone of Wisconsin, and subsequently I sent a drawing of the same to M. Barrande. In 1855, I obtained from the Potsdam Sandstone of the Upper Mississippi River, a fragment of what appeared to be a spine of a crustacean, of very remarkable and peculiar structure, reminding one of that bone; and which might at one time, before we had accustomed ourselves to limit the geological range of fishes, have been taken for an ichthyic remain.

This fragment remained in my collection a subject of much interest, for I was aware, from its structure, that it could belong to no genus of Trilobites, but at the same time I did not think it worth while to publish any notice of it from its incompleteness.

In 1857, Mr. Daniels, of the Geological Survey of Wisconsin, discovered in the Potsdam Sandstone of Black River, in that State, tracks similar to those described by Sir W. E. Logan in the sandstone of Canada. This added a new interest to the unknown crustacean fragment; and in 1860 I visited the Black River region, to procure, if possible, some of these impressions. I failed however in finding the precise locality; and in 1862 sent my assistant in the Wisconsin survey, Mr. Hale, to make further explorations, but he did not succeed in finding anything of interest. At another locality, however, he obtained some fragments of the crustacean before mentioned, among which are two cephalic shields sufficiently perfect to be characterized. I enclose you a drawing of one of these.

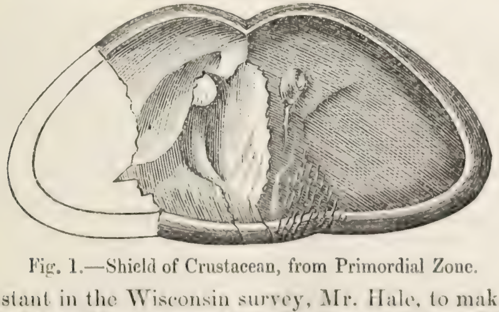

Fig. 1.—Shield of Crustacean, from Primordial Zone.

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* 'Canadian Naturalist' for August, 1862.

The relations to Limulus are at once suggested by the form and expression of these carapaces, while the large prominent eye-tubercles hold relatively the same position as the small approximate oculiform tubercles or spots on the anterior part of the shield in Limulus (and also in Eurypterus). The carapace is proportionally flatter than in Limulus, and has, like that, a strong thickened border; the posterior angles rounded. The margin is impressed or sinuate in front, and there are slight indications of longitudinal grooves on each side of the central, leaving a median lobe proportionally wider than in Limulus. The eyes, though imperfect, remind one somewhat of the eyes of Trilobites, and are remarkably prominent.

There is a single fragment of what appears to have been an articulation of the thorax, or a portion of some appendage analogous to the branchial feet of Limulus; it has a flattened, curving, pointed extremity. Another fragment I infer may have been the caudal extremity, it is comparatively thick and strong; but the specimen is too imperfect to be determined. The first specimen I obtained is a straight spine-like body, and I infer that the animal may have been provided with a caudal spine, as in Limulus.

Such, in general, are the characters of this crustacean. Whether this may have been the animal which made the peculiar tracks in the sandstone, I cannot say, but I have so inferred. The first specimen was found at a distance of thirty miles or more in a north-westerly direction from the locality of the tracks of Black River, and in higher beds of the sandstone. The last found specimens are from a more distant locality, in a south-easterly direction, and also from beds above those of the tracks. All this, however, cannot furnish matter for argument against the origin of the tracks, in the present state of our knowledge of a country which has been comparatively but little explored.

Whatever may be proved hereafter in this respect, it does not diminish the great interest attaching to so new and remarkable a form of crustacean from the unequivocal primordial zone of the north-west.

CORRESPONDENCE.

Causes of Cosmical Changes of Temperature on our Planet.

It is the essential character of space to be infinite. It can have no end. The negation of limit becomes the transcendental affirmative of the infinite. Not so of matter; matter is finite, its position in space being regulated and determined by universal resultants, the effects of its mass and attractions. Heat can only exist in that portion of space which is occupied by matter; for whether caloric be a fluid or a wave, it can have no existence in pure space where no matter exists, pure space being a negation of everything that is material. It necessarily follows that the thermal portions of space must be material.

Mr. Mackie's supposition, in the last number of the 'Geologist,' that the cosmical temperature of space should be the real zero, or absence of all heat, is correct, inasmuch as the absence of matter implies the necessary absence of heat; in the chemical sense, however, it is not a zero, but a mere negation; the real zero as a material condition can never be ascertained. It has been asked "on what grounds the idea of hot and cold regions of space can be maintained," etc., for I brought forward this theory as a solution of the glacial periods in the temperate latitudes of our earth.

Every fact goes to prove that thermal intensity, whether it be a wave (a vibration) or a fluid, is not uniform. Light and heat cannot be uniformly distributed through space, for the causes that generate them are not uniform in regard to intensity and distance.

The outside limit of the thermal ocean in space must be almost infinitely attenuated, and there is no evidence that refrigeration proceeds in a uniform ratio from the centre to the circumference of the material universe, nor is there any proof that our system revolves in a circle equidistant from the cosmic centre. There is therefore no evidence whatever that our path through space is isothermal. It has also been stated by the editor of the 'Geologist,' that to say, that the present meteorological changes on our earth are insufficient to explain the glacial eras, is merely a dogmatic assertion. In reply I have only to say, that if it be a dogmatic assertion, it is founded on faith in the invariable certainty and sequence of natural law, Have we not the wonderful and hitherto unexplained fact, that the polar regions once enjoyed the climate of Italy?—that the *Sequoia Langsdorfi* (a Californian plant), the walnut, the plane-tree, and the vine once flourished within the Arctic Circle? (Steenstrup and Beer.) Is it not an incontrovertible fact that Mount Lebanon was once covered with ice and snow? I think it will be universally admitted that these facts are incapable of explanation by any known laws of our present telluric meteorology, and also that our path through space is not isothermal, which latter supposition, supported as it is by physical facts, will fully explain all the phenomena of terrestrial glaciation.

In reply to the question in the last number of the 'Geologist,' "what is the presumed temperature of the old cosmical space through which our globe is so hypothetically supposed to have passed in the glacial age?" I have to say that the solution to this query can only be found in vital thermometry,—in the changes north and south of the isozoic zones. For it is quite clear that during the period the earth was passing through the cold regions of space the isozoic zones moved towards the equator; and that while it was passing through warmer regions of space, the isozoic zones descended nearer the poles. Therefore from the changes of the isozoic zones on the earth's surface, an approximate calculation might be made of the various cosmical temperatures through which our solar system passed during the glacial geological periods so clearly recorded on the earth's surface.

[If heat only exist where matter is, it must be subject to the laws of matter, and as a physical force would be in direct correlation with the other physical forces; and if heat be confined to matter, how can we speak of hot and cold regions of space, where by that very admission neither heat nor cold can be? Again, if confined to matter, it will, as far as our earth is concerned, be confined to that matter with which our earth is in contact, *i. e.* the great sphere of ethereal matter surrounding the sun, which is warmed by his rays and lit by his light, put in motion by his attraction or repulsion. If the sun moves on with his surrounding worlds, these will all travel onwards together in the same ethereal material envelope; and therefore, unless the supposed hot and cold regions of space have temperatures of much higher or much lower degrees than the general temperature of the solar region, the effect would be imperceptible. In this event, must we not suppose a radiation inwards of heat from space towards the sun, and consequently, one would suspect, a stoppage of all radiation from the earth? But heat is a form of motion, and motion seemingly necessitates the existence of matter. If so, therefore—if heat exist in space—all space without end must be material. Can heat or cold exist in *void* space? There is no cause whatever, no physical action, that I know of, that should either produce or accumulate heat in space or produce heated masses of space. Chemical combinations and chemical decompositions of matter might produce spheres of heated material space, but we have no data yet for such an assumption.—Ed. Geol.]

The Portland Ossiferous Fissures.

Sir,—The Rev. T. Allen's letter on the Portland fissures in your last number, induces me to send you a second communication upon that question. I have visited Portland during the present month, and descended one of the fissures, in which a large number of bones were found some months ago by a warder of the name of Maddock. I obtained all the information I was able from Mr. Maddock on the subject, and saw most of the bones. They are deposited in the Government Office at the Vern Fort. Lieutenant Home, R.E., was kind enough to allow me to examine them thoroughly, and gave me much information and assistance in investigating the phenomena of the gullies.

I must premise that I did not examine any gullies in that portion of the island where the Portland beds are overlaid by the Lower Purbeck calcareous shale.

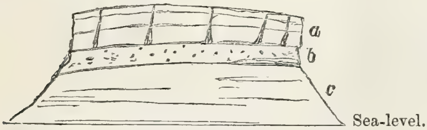

Fig. 1.—Section showing the Portland fissures. *a*, stone, fissured; *b*, sandy clay; *c*, shaly clay.

I saw at a glance that the explanation I offered in a former communication to your Journal was incorrect. *Shrinkage* will not account for these fissures. They appear to arise from a ponderous stone-structure being raised by nature on a bad foundation.

They extend as nearly as possible in the direction of the length of the island; and are possibly connected with the last great movement, which affected the configuration of that part of the coast. This movement seems to have been posterior to the outspread of gravel on the heights to the north of the Ridgway fault: for the elevated beds to the south of the fault are bare of gravel.

On the west side of the northern end of Portland the beds are much broken and tumbled seawards, the gullies being very numerous. Slips occur on this side of the island. On the whole, I conclude that Portland is the remnant of an oblong mass of strata brought into its present position by the disturbances alluded to. There is a very curious miniature model of the island between Upwey and Bincombe, formed by the combined effects of faulting and denudation, and in the same series of beds that occur at Portland itself.

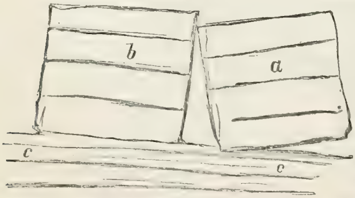

Fig. 2.—Ideal section showing nature of slip of beds in forming a fissure: *a*, *b*, masses of stone-rock, subsiding on the unequally-yielding bed of sandy clay, *c*.

The general structure of the gullies seems to be due to a slip of such a kind that they are more open at the bottom than at the top. (Fig. 2.)

One side has usually slightly sunk a foot or so. The jagged edges of broken stones and flints correspond on the two sides of the fissure. The rock seems a good deal shaken on both sides of the larger fissures.

With regard to the question of the fissures being open or closed at the top, the above description of them will show that, on the whole, they tend to be closed. Yet they are not so entirely. Often they seem to be roofed by fragments that have fallen in from their sides, and have got jammed, and subsequently smaller fragments and rubbish have accumulated upon these. Certainly at the present day there are no gaping chasms on the surface of the island, and this may have led to its being commonly said that the gullies are closed at the top. It seems probable that, where the massive Portland rock is capped by slaty stone, the latter may have continued to roof the fissures, and, as a rule, the fissures may not affect the Purbecks; but I cannot speak on this point from observation.

In the fissure which I entered I was stopped by a true talus of surface-mould, abounding in Helices and Cyclostomæ, with a few splinters of bone. These materials had most evidently been gradually introduced through some orifice in the upper surface by the action of rain. I may have traversed the fissure for about fifty yards. The true bottom was not visible; for a quantity of loose stones had been cast into it. The part of it where the bones were found is now choked up. I should conclude, from the description which Mr. Maddock gave me, that the bones, in falling from above, lodged upon a ledge of rock; and probably, if the base of the fissure were reached, many more would be found there.

Among these bones were no human bones. I did not see any such that had been found in the fissures in the Government works, but I saw a sling-stone, formed of Portland flint, which Lieutenant Home assured me he had himself taken from a gully, at a depth of 80 feet from the surface. He also told me that he had once in his possession a brecciated mass of bones, containing among them human bones; and that it had been found in a gully in making the ditch of the fort, but that it had been stolen.

The explanation given above of the cause of the formation of the fissures is that which commends itself to the intelligent persons engaged upon the Government works, and was suggested to me in the first place by Mr. Home. I subjoin a sketch of the top of a gully on the north-west side of the Vern Hill, looking north.

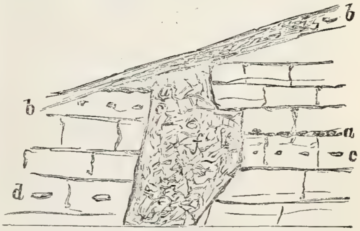

Fig. 3.—Section of gully, N.W. side of Vern Hill, Portland.

In this case the gully was evidently once open, though now filled with rubble. The beds have sunk about two feet on the east side.

I remain, Sir, faithfully yours,

Elmstead, Colchester, June 17th, 1863. O. FISHER.

The Portland Ossiferous Fissures.

SIR,—With reference to Mr. Allen's letter in your number for last month, I beg to say that I do not doubt the truth of his statement, but merely the soundness of the inferences drawn therefrom. I presume he is aware that in what he says about the "deluge" and the bones of extinct animals he is opposed to some of the most advanced geologists of the present day, in the opinion of whom the idea of a "universal deluge" must be given up, and who also think that the fossil remains of elephants, rhinoceroses, etc., belonged to species peculiarly adapted to exist in a temperate and even a comparatively arctic climate, of which the "Siberian mammoth" and woolly rhinoceros mentioned by Professor Owen, in his 'History of British Fossil Mammalia,' are appropriate examples. Hoping you will excuse my thus trespassing on your valuable space,

I remain, yours truly,
CHARLES JECKS, JUN.

Woodlands, Thorpe, near Norwich, June 8, 1863.

The Portland Ossiferous Fissures.

Sir,—In answer to the objections, which you have made in the last number of the 'Geologist,' to my opinion of the cause of the remains of men and of extinct mammalia being found in fissures of the Portland rock, which fissures do not extend to the surface of the rock, will you allow me to make a few observations?

In the first place, I think there can be no doubt that human and other bones have been thus found. This fact, as I have before stated, is positively asserted in 'Willis's Current Notes' for August, 1852, and in an article in the 'Times' of the 1st of last January; and has been frequently confirmed to me by Captain Manning, of Portland Castle, who has shown me the bones of men, of elk, reindeer, elephant, and of other animals which were found associated together in fissures, which, he said, did not extend to the surface of the rock. You say: "How could there be a fissure before the rock was consolidated, and are we to believe that the elephants, etc., and men too, lived at the bottom of the sea, as they must be supposed to have done if we accept Mr. Allen's theory?" But in both of my letters, I said that I believed that the human and other bones must have been imbedded in the rock *before* its consolidation, and consequently before the existence of any fissures; and that, therefore, the men and animals to whom they belonged must have lived on some other dry land, which probably no longer exists. My opinion is, that these fissures were gradually formed in the semi-fluid limestone deposit, partly by the human and other remains embedded in it and the putrid vapours arising from their corrupting bodies, and partly by the contraction of the calcareous deposit during the process of its drying. I believe that all the remains were imbedded in the soft limestone at that interchange of land and sea of which M. Cuvier speaks in the following words:—"I conclude," he says, "with M. de Luc and M. Dolomieu, that if there be any fact well established in geology it is this, that the surface of our globe has suffered a great and sudden revolution, the period of which cannot be dated further back than five or six thousand years. This revolution has, on one hand, engulfed and caused to disappear the countries formerly inhabited by men and the animal species at present best known, and, on the other, has laid bare the bed of the last ocean, thus converting its channel into the present habitable earth." I think, also, that there is the strongest geological proof that the remains of extinct quadrupeds found in caverns in limestone, were imbedded in the limestone *before* its consolidation, and, consequently, before the existence of the caverns themselves; and that therefore the animals to whom they belonged must have previously inhabited some other dry land. For there is evidence that many of these caverns have had no mouths as none have as yet been discovered, at Oreston, near Plymouth. Dr. Buckland, in his 'Reliquiæ Diluvianæ,' mentions three of these caverns, in which were numerous remains of extinct mammalia, which were only discovered by men digging in a quarry for stone for building the Plymouth breakwater. He says that these caverns were "discovered by Mr. Whidbey in removing the *entire mass of a hill* of transition limestone, and that none of them had any discoverable communication with the surface of the earth. In the 'Times' of January 22, 1859, I read a statement that "there had recently been discovered in one of the limestone *quarries* at Oreston, the teeth, bones, and other remains of lions, tigers, elephants, rhinoceroses, horses, hyænas, and other animals. The cavern from which the fossils were extracted was situated in the solid rock in the cliff of a quarry. There was no aperture or other indication of its locality.

Among the contents is the jaw of an animal of the horse species, in stalagmite, exceedingly perfect." The fossils were said to be in the possession of Mr. Joseph, mineralogist, of Plymouth. In consequence of reading this account, I wrote to Mr. Joseph, requesting him to have the kindness to inform me whether the facts mentioned in the 'Times' were in every respect correct. He returned for answer that they were so; and said that there was no aperture in the cavern, and that some of the bones were imbedded in "compact rock." It appears from Dr. Buckland's 'Reliquiæ Diluvianæ,' that almost all, if not all, bone-caverns which have apertures through which the animals could have passed are situated in the face of precipitous cliffs, produced, as Dr. Buckland says, by valleys of denudation excavated by the retiring waters of a transient inundation. I think, therefore, that except for the excavation of these valleys, the existence of the caverns would probably have never been known. The Kirkdale cave itself, which is full of the remains of immense mammalia, was, as Dr. Buckland says, only discovered by men digging in a quarry, and thus laying open, to the extent of 30 feet, the cave itself, and forming, in the perpendicular face of the quarry, an entrance of 3 feet high and 5 broad. Dr. Buckland thinks that there may be many similar caverns in the neighbourhood of Kirkdale, whose existence can only be discovered by "their casual intersection by some artificial operation;" and he says that, "in these circumstances we see a reason why so few caverns of this kind have hitherto been discovered, although it is probable that they are very numerous." From the fact that few, if any, bone-caverns have been discovered with apertures through which animals could have passed, except caverns situated in the face of precipitous cliffs, produced, according to Dr. Buckland, by diluvial denudation, it seems to me certain that all bone-caverns were only formed by the animal remains imbedded in the limestone deposit before its consolidation, and, consequently, that the animals themselves must have originally inhabited some other dry land which may no longer exist. Lastly, as almost all the fossil remains of men or animals found in caves are buried in loam, which, as Dr. Buckland asserts, was carried into the caves by an inundation, it is probable that the same water which introduced this loam introduced the bones imbedded in it.

I am, Sir, your obedient servant,
Thos. D. Allen.

Rectory, North Cerney, Cirencester, June 12, 1863.

[How were the bones of men, mammoths, and reindeer separated and deposited only in the forming fissures in a semifluid limestone? The bones of men, mammoths, and reindeer would have been commingled *with* the shell-fish and other marine remains in the Portland rock, if they had existed at that period and were washed into the Portland Sea. Mr. Allen had better honestly look at the sections, fissures, and limestones for himself, and get some of the human and mammal bones out in the presence of good and able witnesses, as M. de Perthes has lately done at Abbeville. It will be a hard matter for him to get the world to believe in Oolitic men and mammoths, unless on better authority than 'Willis's Notes' or a stray paragraph in the 'Times.' Ossiferous fissures are not rare. They occur in a vast number of places, and there is no reason to believe the infilled remains in the Portland fissures are a whit more ancient than such remains are usually considered to be. Nothing has yet turned up to show that man is not one of the latest-created animals, and as yet not the slightest indication has been obtained in any part of the world of the existence of human beings in the Jurassic age. Mr. Allen's theory of the deposition of the extinct animals in caves before the caves existed is so ingenious and *naïve*, that we leave it without comment for the amusement of our readers, for fear our remarks might spoil the joke. By the allusion to the Oreston quarries, we presume Mr. Allen wishes to infer that there were men in the mountain-limestone age. Are we shortly to be treated to footprints of man and works of his architecture and handicraft in the Cambrian slates? Mr. Allen must not expect many converts to his geological heresy unless he give us irresistibly convincing proofs. We are not willing to close our columns against any expression of opinion, however rash or wrong it may at first sight appear,—the wildest might turn out right at last; but we cannot permit any further discussion of these Portland fissures, unless positive sections to scale with the position of these mammal bones or some practical details are submitted to us.—Ed. Geol.]

Age of the Trinidad Strata.

Dear Sir,—Perhaps you will allow me to make a remark in connection with a statement occurring in Mr. Guppy's paper on the Parian Formation of Trinidad. He mentions sandstones containing a Trigonia, Belemnites, and other fossils belonging to a period represented by a series of rocks on the continent of Europe, known as the Neocomian. What I wish to suggest is, that it is more than probable that the beds in Trinidad were not of Neocomian age, as Mr. Guppy says. Are we to suppose it probable, or even possible, that there was no variation of fauna in geological periods, and that the occurrence of two or three species of mollusca together in different localities, furnishes proof of their existence? Can geologists point to certain species of shells, and say, "Wherever these are found together imbedded, we know the rocks containing them to have been contemporaneous"?

Suppose the existing fauna of the world to become fossils, where should we find species to characterize it? By what two or three species would a geologist be able to distinguish the deposit from any that preceded it? Would he not be very likely to place the Australian beds as contemporaneous with our Oolites (the absence of Cephalopoda being the only remarkable difference)? and he would most probably, according to the system now pursued in geological classification, assign a different period to nearly every existing fauna. Geologists are, it seems, too much impressed with an idea of "contemporaneity." As Professor Huxley said, in his Address to the Geological Society, 1862, "it would have been very much better for geology if so loose and ambiguous a word as 'contemporaneous' had been excluded from her terminology, and if in its stead some term expressing similarity of serial relation, and excluding the notion of time altogether, had been employed to denote correspondence in position in two or more series of strata." Professor Huxley proposes to substitute the word "homotaxis" as more correct, and avoiding the production of an erroneous impression. Edward Forbes was in the habit of asserting that the similarity of the organic contents of distant formations was *primâ facie* evidence, not of their similarity, but of their difference of age. It would be well if geologists were more attentive to these facts. Many conclusions which are now held as undeniable would be shaken from their foundations, and geology would have a difficulty removed from her path which must sooner or later make itself known. E. R. Lankester.

Remarkable Coal-Plant.

Sir,—I have lately found in a seam of coal a stem of Sigillaria which throws considerable light on the compound character of some of our common Coal-plants, and tends somewhat to simplify a portion of fossil botany. The circumference of the specimen is 1 foot 6 inches, and after the removal of a coaly envelope of outer bark, presents the irregularly-ribbed and furrowed surface, with occasional scars, so often seen on old Sigillariæ and their main roots. The central axis is cylindrical, and shows on its transverse section a *Medullosa* resembling one described by Cotta. The outside of this cylinder is striated longitudinally, like a Calamite, and not to be distinguished from the *Calamites remotus* of Brongniart. Next comes a cylinder of wedge-shaped bundles of barred vessels, in radiating series, parted by spaces resembling medullary rays, in all respects similar to that found in *Stigmaria, Sigillaria,* and *Anabathra.* Outside of the last, with a small interval, is another cylinder composed of vessels not barred, arranged in radiating series, and parted by large wedge-shaped bundles of vessels running towards the circumference. The structure of this outer cylinder is identical with that of *Calamodendron,* and its exterior has the irregularly-ribbed and furrowed appearance previously alluded to.

Yours truly,
EDWARD WILLIAM BINNEY.

Manchester, June 10th, 1863.

FOREIGN INTELLIGENCE.

The question of the contemporaneity of man with extinct species of animals has again been brought before the Academy of Sciences by a paper of M. J. Desnoyers, on the 8th ultimo, in which he announced his having met with materials indicating the co-existence of man with the *Elephas meridionalis,* in a deposit in the environs of Chartres, of greater age than the drift of the valleys of the Somme and the Seine. These indications are kinds of notches or streaks made by the human hand, which he has observed on many of the fossil bones of many of the great extinct mammals found in that deposit at Saint-Prest, near Chartres. M. Desnoyers also notices indications of the same character in bones from other localities. The conclusions deduced in his paper are—that fossil bones of *Elephas meridionalis, Rhinoceros leptorhinus, R. Etruscus, Hippopotamus major,* many of large and small deer, and other species of mammifers characteristic of the Upper Tertiary or Pliocene strata, discovered in an undisturbed deposit of that geological age, bear numerous and evident traces of notchings, scratches, and cuts which are perfectly analogous to those which have been observed on the fossil bones of other more recent species, some of which, now extinct, accompanied the *Elephas primigenius, Rhinoceros tichorhinus, Ursus spelæus, Hyæna spelæa,* etc., and others still living, such as the Reindeer and other deer, the Aurochs, etc., but remains of which are found commingled together in ossiferous caverns, in drift-beds, or in peat. Like vestiges have been met with on numbers of bones of existing species in the excavations for houses, and in Celtic, Celto-Roman, and Saxon graves. The marks noted on the fossil bones from the most ancient beds appear to have had, for the most part, the same origin as those on the more recent bones, and cannot be, so far as we yet know anything to the contrary, attributed to any other source than the act of man. Other striæ, finer, rectilinear, and inter-crossing, which are seen also in great number on the bones from the Pliocene deposit of the neighbourhood of Chartres and from other localities, are analogous to those seen on striated and rolled boulders of ancient and modern glaciers. The section at Saint-Prest, unanimously recognized as Upper Tertiary, or Pliocene, and anterior to all the quaternary beds containing remains of *Elephas primigenius*, yields numerous bones of *Elephas meridionalis* and other of the great kinds of mammalia characteristic of the Pliocene beds.

From these facts, then, it is possible to conclude with a strong appearance of probability, that man inhabited the soil of France before the great and first glacial era, contemporaneously with the *Elephas meridionalis* and the other species of fossil mammals of the Val d' Arno, in Tuscany, which are identical with those of Chartres, and which species are Tertiary, and more ancient than the *Elephas primigenius* found with the relics of man in the diluvial beds of valleys and caverns.

The Saint-Prest bed offers the most ancient example yet given in Europe of the vestiges of man with the extinct beasts. It diminishes in no way the interest and importance of the Abbeville and Amiens discoveries, but, on the contrary, confirms their reality by a new argument, and by totally independent observations the evidence recently obtained by M. Boucher de Perthes and verified with so much care by the naturalists of England and France.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Royal Institution of Great Britain.—*June 5th.*—" On the Forms of the Stratified Alps of Savoy." By John Ruskin, Esq., F.G.S. The purpose of the discourse was to trace some of the influences which have produced the present external forms of the stratified mountains of Savoy, and the probable extent and results of the future operation of such influences.

The subject was arranged under three heads :—I. The Materials of the Savoy Alps. II. The Mode of their Formation. III. The Mode of their subsequent Sculpture.

I. *Their Materials.*—The investigation was limited to those Alps which consist, in whole or in part, either of Jura limestone, of Neocomian beds, or of the Hippurite limestone, and include no important masses of other formations. All these rocks are marine deposits ; and the first question to be considered with respect to the development of mountains out of them, is the kind of change they must undergo in being dried. Whether prolonged through vast periods of time, or hastened by heat and pressure, the drying and solidification of such rocks involved their contraction, and usually, in consequence, their being traversed throughout by minute fissures. Under certain conditions of pressure, these fissures take the aspect of slaty cleavage ; under others, they become irregular cracks, dividing all the substance of the stone. If these are not filled, the rock would become a mere heap of débris, and be incapable of establishing itself in any bold form. This is provided against by a metamorphic action, which either arranges the particles of the rock, throughout, in new and more crystalline conditions, or else causes some of them to separate from the rest, to traverse the body of the rock, and arrange themselves in its fissures ; thus forming a cement, usually of finer and purer substance than the rest of the stone. In either case the action tends continually to the purification and segregation of the elements of the stone. The energy of such action depends on accidental circumstances. First, on the attractions of the component elements among themselves ; secondly, on every change of external temperature and relation. So that mountains are at different periods in different stages of health (so to call it) or disease. We have mountains of a languid temperament, mountains with checked circulations, mountains in nervous fevers, mountains in atrophy and decline.

This change in the structure of existing rocks is traceable through continuous gradations, so that a black mud or calcareous slime is imperceptibly modified into a magnificently hard and crystalline substance, enclosing nests of beryl, topaz, and sapphire, and veined with gold. But it cannot be determined how far, or in what localities, these changes are yet arrested; in the plurality of instances they are evidently yet in progress. It appears rational to suppose that as each rock approaches to its perfect type the change becomes slower; its perfection being continually neared, but never reached; its change being liable also to interruption or reversal by new geological phenomena. In the process of this change, rocks expand or contract; and, in portions, their multitudinous fissures give them a ductility or viscosity like that of glacier-ice on a larger scale. So that many formations are best to be conceived as glaciers, or frozen fields of crag, whose depth is to be measured in miles instead of fathoms; whose crevasses are filled with solvent flame, with vapour, with gelatinous flint, or with crystallizing elements of mingled natures; the whole mass changing its dimensions and flowing into new channels, though by gradations which cannot be measured, and in periods of time of which human life forms no appreciable unit.

II. *Formation.*—Mountains are to be arranged, with respect to their structure, under two great classes—those which are cut out of the beds of which they are composed, and those which are formed by the convolution or contortion of the beds themselves. The Savoy mountains are chiefly of this latter class. When stratified formations are contorted, it is usually either by pressure from below, which raises one part of the formation above the rest; or by lateral pressure, which reduces the whole formation into a series of waves. The ascending pressure may be limited in its sphere of operation; the lateral one necessarily affects extensive tracts of country, and the eminences it produces vanish only by degrees, like the waves left in the wake of a ship. The Savoy mountains have undergone both these kinds of violence in very complex modes and at different periods, so that it becomes almost impossible to trace separately and completely the operation of any given force at a given point.

The speaker's intention was to have analysed, as far as possible, the action of the forming forces in one wave of simple elevation, the Mont Salève; and in another of lateral compression, the Mont Brezon: but the investigation of the Mont Salève had presented unexpected difficulty. Its façade had been always considered to be formed by vertical beds, raised into that position during the Tertiary periods; Mr. Ruskin's investigations had, on the contrary, led him to conclude that the appearance of vertical beds was owing to a peculiarly sharp and distinct cleavage, at right angles with the beds, but nearly parallel to their strike, elsewhere similarly manifested in the Jurassic series of Savoy, and showing itself on the fronts of most of the precipices formed of that rock. The attention of geologists was invited to the determination of this question.

The compressed wave of the Brezon, more complex in arrangement, was more clearly defined. A section of it was given, showing the reversed position of the Hippurite limestone in the summit and lower precipices. This limestone-wave was shown to be one of a great series, running parallel with the Alps, and constituting an undulatory district, chiefly composed of chalk beds, separated from the higher limestone-district of the Jura and Lias by a long trench or moat, filled with members of the Tertiary series—chiefly nummulite limestones and flysch. This trench might be followed from Faverges, at the head of the Lake of Annecy, across Savoy. It separated Mont Vergi from the Mont Dorons, and the Dent d'Oche from the Dent du Midi; then entered Switzerland, separating the Moleson from the Diablerets; passed on through the districts of Thun and Brientz, and, dividing itself into two, caused the zigzagged form of the Lake of Lucerne. The principal branch then passed between the high Sentis and the Glarnisch, and broke into confusion in the Tyrol. On the north side of this trench the chalk beds were often vertical, or cast into repeated folds, of which the escarpments were mostly turned away from the Alps; but on the south side of the trench, the Jurassic, Triassic, and Carboniferous beds, though much distorted, showed a prevailing tendency to lean towards the Alps, and turn their escarpments to the central chain.

Both these systems of mountains are intersected by transverse valleys, owing their origin, in the first instance, to a series of transverse curvilinear fractures, which affect the forms even of every minor ridge, and produce its principal ravines and boldest rocks, even where no distinctly-excavated valleys exist. Thus, the Mont Vergi and the Aiguilles of Salouvre are only fragmentary remains of a range of horizontal beds, once continuous, but broken by this transverse system of curvilinear cleavage, and worn or weathered into separate summits.

The means of this ultimate sculpture or weathering were lastly to be considered.

III. *Sculpture.*—The final reductions of mountain form are owing either to disintegration, or to the action of water, in the condition of rain, rivers, or ice; aided by frost and other circumstances of temperature and atmosphere.

All important existing forms are owing to disintegration or the action of water. That of ice had been curiously overrated. As an instrument of sculpture, ice is much less powerful than water; the apparently energetic effects of it being merely the exponents of disintegration. A glacier did not produce its moraine, but sustained and exposed the fragments which fell on its surface, pulverizing these by keeping them in motion, but producing very unimportant effects on the rock below; the roundings and striation produced by ice were superficial; while a torrent penetrated into every angle and cranny, undermining and wearing continually, and carrying stones, at the lowest estimate, six hundred thousand times as fast as the glacier. Had the quantity of rain which has fallen on Mont Blanc in the form of snow (and descended in the ravines as ice) fallen as rain, and descended in torrents, the ravines would have been much deeper than they are now, and the glacier may so far be considered as exercising a protective influence. But its power of carriage is unlimited, and when masses of earth or rock are once loosened, the glacier carries them away, and exposes fresh surfaces. Generally, the work of water and ice is in mountain surgery like that of lancet and sponge—one for incision, the other for ablution. No excavation by ice was possible on a large scale, any more than by a stream of honey; and its various actions, with their limitations, were only to be understood by keeping always clearly in view the great law of its motion as a viscous substance, determined by Professor James Forbes.

The existing forms of the Alps are, therefore, traceable chiefly to denudation as they rose from the sea, followed by more or less violent aqueous action, partly arrested during the glacial periods, while the produced diluvium was carried away into the valley of the Rhine or into the North Sea. One very important result of denudation had not yet been sufficiently regarded; namely, that when portions of a thick bed (as the Rudistenkalk) had been entirely removed, the weight of the remaining masses, pressing unequally on the inferior beds, would, when these were soft (as the Neocomian marls), press them up into arched conditions, like those of the floors of coal-mines in what the miners called "creeps." Many anomalous positions of the beds of Spatangen-kalk in the district of the Lake of Annecy were in all probability owing to this cause: they might be studied advantageously in the sloping base of the great Rochers de Lanfon, which, disintegrating in curved, nearly vertical flakes, each a thousand feet in height, were nevertheless a mere outlying remnant of the great horizontal formation of the Parmelan, and formed, like it, of very thin horizontal beds of Rudisten-kalk, imposed on shaly masses of Neocomian, modified by their pressure. More complex forms of harder rock were wrought by the streams and rains into fantastic outlines; and the transverse gorges were cut deep where they had been first traced by fault or distortion. The analysis of this aqueous action would alone require a series of discourses; but the sum of the facts was that the best and most interesting portions of the mountains were just those which were finally left, the centres and joints as it were of the Alpine anatomy. Immeasurable periods of time would be required to wear these away; and to all appearances, during the process of their destruction, others were rising to take their place, and forms of perhaps far more nobly organized mountain would witness the collateral progress of humanity.

Manchester Scientific Students' Association.—The Association originated in the latter part of 1861, by the efforts of a few ardent lovers of science, who, stimulated by the recollection of the great pleasure they had derived from attending the sectional meetings of the British Association on the occasion of its visit to Manchester, conceived the project of organizing in that city a permanent association, to enable students to meet frequently for the discussion of scientific topics, and to afford them opportunities of frequent intercourse. The institution numbers some seventy members or more, and during the two sessions of last year, thirty lectures were delivered and five *conversaziones* held, one of which latter was geological. Amongst the lectures were the following geological topics:—"The Coal Formation and its Fossils," by Mr. G. Butterworth; "The Chemistry of Coal," by Mr. James Richards; "On Volcanic Action," by Mr. T. Moss; "Geological Traces of Primæval Man," by Mr. W. C. Unwin; "Iron," by Mr. R. Drew; "The Chalk Formation," by Mr. S. Shirley; "On Vertebrate Life—its History and Peculiarities," by Mr. G. D. Hatton; "On Gold," by Mr. R. Drew. During the present year the geological lectures have been "The Hypozoic Rocks," by Mr. Richard Smith; "The Lowest Fossiliferous Rocks of England," by Mr. Samuel Shirley; "The Devonian System," by Mr. George D. Hatton; "The Flora of the Coal-Measures," by Mr. William Grindon; "Ice as an Agent of Geological Change," by Mr. F. Carulla; "Fossil Saurians," by Mr. E. Butterworth. Excursions have also been made; amongst them, visits to the collieries of Worsley and Pendleton, and to the copper and lead mines at Alderley.

Richmond Mechanics' Institute.—Mr. S. W. North, of York, has lectured on the antiquity of man. The title of his lecture was, "Has not Man existed a hundred thousand years?" The now, to geologists, familiar topics were treated with lucidity and perspicuity, the lecturer agreeing in the recognized conclusions of the high antiquity of the human race, and the evidences of the fossil flint-implements which, as "works of his hands," he considers speak in unmistakable terms of man's presence, and serve to tell, not only of his existence, but something of his history."

Geologists' Association.—On the 20th ult. a number of the members of this association assembled at Kew Gardens, where, under the guidance of Professors Tennant and Morris, they inspected minutely the various plants that have an interest for geologists; particularly the magnificent collection of ferns, in connection with the fossil ferns of the coal-measures. The plants that characterize the Oolitic and Tertiary beds were also illustrated with reference to modern groups. On the 24th ult. the Association made an excursion to Herne Bay and Reculver, where the most competent of the members delivered field lectures on some of the Secondary and Tertiary formations exposed on the coast between those places.

Cotteswold Naturalists' Field Club.—A most interesting and numerously attended meeting of this Club took place on 27th May, at Bownhill, Woodchester, where, by the permission of William Leigh, Esq., the proprietor of the estate, a tumulus was opened, under the superintendence of Mr. E. Witchell and Dr. Payne, of Stroud. On leaving the barrow, Mr. Samuel S. Marling, of Stanley Park, invited the Club to luncheon. From this point the President and Secretary proceeded, under the guidance of Mr. Witchell, to a neighbouring brick-kiln, to examine the fullers'-earth; thence to Penwood Quarry, where the bastard freestone is laid open to a depth of twenty-five feet, upon which rests the lower trigonia bed with its characteristic fossils; and onwards to a freshwater formation, exposed during the excavation of a reservoir on the side of the hill, at a considerable elevation above the town. From the organic contents it was presumed to represent the bottom of a small hill-lake, of which the margin towards the vale has long been swept away. The shells found in it comprise the same species which are constantly found in the tufaceous accumulations of the district, and which still inhabit it—*Cyclostoma elegans, Helix rotundata, H. umbilicata, Pupa umbilicata, Zua lubrica, Azeca tridens,* and *Carychium minimum,* as land-shells; *Valvata piscinalis, Lymnæus truncatulus,* and two or three species of *Pisidium,* as water-shells. The Rev. S. Lysons, availing himself of the presence of Dr. Thurnham, and Mr. Cunnington, of Devizes, Mr. D. Nash, and other ethnologists from Cheltenham, submitted for examination four skulls exhumed by him from the tumulus recently opened at Rodmarton. After dinner at the George Hotel, several gentlemen took part in a long and animated discussion on the events of the day, and upon the views expressed in a paper, by Captain Bell, "on the rough unhewn Stones of Cromlechs, Circles, and Chambered Tumuli," in which he inclined to the opinion that no tools were used upon them from superstitious motives, or reverential feelings due to the wide diffusion of the divine command repeatedly referred to in the Scriptures, where altars are especially mentioned as of unhewn stone.* He argued that the tool-marks were not absent from want of skill on the part of the mound-formers, as a knowledge of the powers of the lever, and the construction of sledges upon which ponderous masses were probably removed, implied familiarity with tools of various descriptions. Mr. D. Nash doubted whether iron had not been used, and believed that the stones uncovered to-day, if not hewn, had been shaped to fit them for the purpose to which they were applied. He did not assign to the barrows of this district the high antiquity attributed to them by many antiquaries, and thought that our knowledge of the race by whom they were constructed had become more confused, instead of more clear, by recent discoveries. He thought that the majority of them were of a period subsequent to that of the Roman dominion in Britain, and that they were the work of a people which had derived the civilization to which it had attained from the Romans, and were therefore of Romano-British origin.

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* I have long thought it possible that some of these unhewn stone monuments may be relics of perhaps even the flint-implement men, or, at any rate, a very early race; and have more than once published the idea.—Ed. Geol.

Mr. Cunnington exhibited a beautifully-finished flint celt or adze, nine and a half inches long by three wide at the edge, which had been found, with others, during the present year, at Crudwell, near Malmesbury.

A letter was read from Professor Buckman, accompanied by a geological section, announcing the discovery in Cirencester of a patch of Cornbrash, proving that, as its environs consist of Forest marble and Great Oolite, the town itself is situated in a valley of depression. A letter of thanks from the Geological Society for the contribution to its library of the "Proceedings" of the Club was then read, as was also an invitation to meet the Malvern Club at Dudley, on the 18th of June, from the newly-established Severn Valley Naturalists' Field Club, whose head-quarters are at Bridgnorth.

The proceedings terminated with a paper by the Rev. S. Lysons, on the "Names of Places in Gloucestershire."

MANCHESTER GEOLOGICAL SOCIETY.—*March* 31*st*.—A very important paper was read by Mr. Joseph Dickinson, the President, "On the Coal-Strata of Lancashire."

In the first volume of the Transactions of this Society there are papers "On the Geology of Manchester and its Vicinity," and "On the Geology of the Lancashire and Cheshire Coal-Fields," by Mr. Binney. These papers were given about 24 years ago; but although so many years have elapsed since they were written, Mr. Dickens testified to the accuracy which characterizes most of the information they contain. The author's purpose in his present paper was to give an account of the whole subject, and, in doing so, to "Tell not as new what everybody knows," but, whilst fully acknowledging former authorities, to supply required corrections, together with additional matter of his own.

The base of the Lancashire coal-formation rests upon the mountain limestone, which is seen cropping out near Clitheroe; within no part of the area of the coal-field, however, are the lower measures so much exposed as to exhibit the limestone. It is covered by a very thick deposit of shales and grit, the thickness of which has never yet been correctly ascertained, but probably thicker than at any other part in England.

At the boundary between Lancashire and Cheshire the lowest workable coal-seams crop out at Mossley, near Staleybridge; they then skirt round near the eastern boundary of Lancashire, passing at certain places into Yorkshire (where sometimes, without having cropped out, they dip away again in the opposite direction, and become overlaid by the whole of the Yorkshire coal-field), through to Littleboro'; thence midway between Bacup and Todmorden, passing near the Portsmouth station on the railway between Todmorden and Burnley; then gradually curving a little to the west, including the Worsthorn quarries, and so on nearly to Colne; thence turning in a westerly and south-westerly direction, along Padiham Heights, through Simondstone and Read, where the crop becomes very steep, dipping almost at an angle of 45°; then, leaving Blackburn outside, they pass through Oswaldtwistle to Eccleshill, Over Darwen, across to Chorley, round by Welsh Whittle, Heskin, and thence to Latham Park and Blaguegate; then southward, keeping a little to the west of St. Helens. On the south side the coal strata are overlaid by the Red Rock, or New Red Sandstone, Permian, etc.

The line thus given forms nearly half a basin, and throughout the entire length the general inclination of the strata is inwards to a centre,—the inclination or dip being very much varied by the different faults with which the basin is divided, from nearly level to an angle of 45°.

The coal-measures included in this Lancashire field have been divided into three series, namely,—the lower, or Gannister, the middle, and the upper series. As a general rule, it is said that the lower, or Gannister series, contains some of the best coking coals. It also contains the finest flags and tile stones. It is the principal earth for making firebricks. There are plenty of similar earths in the middle and upper series ; but it would seem that those in the lower series produce bricks which stand greater heat. Like the coals of the lower series, those of the lower portion of the middle series are chiefly good coking coals ; and at the top, or upper portion, swift or hot-burning coals are produced. The coals of the upper series are nearly all hot swift-burning coals. Cannel or Parrot coal is found in each of the three series, but the best is in the middle series.

Commencing at Mossley, near Ashton-under-Lyne, the following section of the lowest coals is met with :—

	yds.	ft.	in.
Sandstone	—	—	—
Coal	0	1	5
Floor earth	0	0	8
Shale and sandstone	29	2	4
Shale	0	2	0
Coal, Victoria	0	1	9
Coal and Bass	0	0	9
Earth	0	0	2
Sandstone	1	0	0
Shale	5	0	0
Sandstone	3	0	0
Shale	4	0	0
Coal	0	0	7

The lowest of these three coals lies at a distance of about 326 yards below the Gannister coal. The principal, or 1 foot 9 inch bed, is the one which is being worked at the Victoria Colliery, at Mossley. The three seams retain their character southwards to Early Bank, in Cheshire ; but northwards they do so for a short distance only, and, except in that immediate neighbourhood, there is no place in Lancashire where coal-seams are so fully developed so low down in the coal-field.

A general section of the principal coal-seams of the lower series near Hartshead is as follows :—

	yds.	ft.	in.
Coal (40-yards mine) . . .	0	1	6
Strata, with an inch of Coal .	34	0	0
Coal, upper foot	0	1	0
Strata	15	0	0
Coal mountain, or ¾ (Gannister)	0	1	10
Strata	10	0	0
Coal, lower toot	0	0	6
Strata	90	0	0
Coal, yard (sand rock) . . .	0	0	6
Strata, about	180	0	0

And then the upper, or one-foot five-inch coal, given on the preceding section, at Mossley.

At Crompton, near Oldham, the lower foot coal is called the half-yard mine, and the Gannister coal is still called the "mountain mine." The upper foot and the 40-yards coal are also still known by the same names. The upper foot coal has there a large number of round nodules both in it and upon it, and also a very large number of fossils, generally *Goniatites* and *Avicula-pectens*.

At Bamford and Ashworth, the 40-yards coal still retains its name, and there is another coal, called the "bassey mine," lying about 30 yards above it.

At Birchinley, near Rochdale, the coals still retain the same names, and also at Dearnley and Cleggswood. Passing on through Whitworth and Wardle to Bacup, the 40-yards mine takes the name of the little or top, or half-yard mine. At Whitworth, Wardle, etc., portions of the Gannister coal, where it originally cropped out all round some of the hills, have been entirely worked out, and small workings are commenced on the lower foot-mine. The Gannister coal at Bacup is called the yard, or main coal; the lower foot and the sand-rock mines still retaining their names.

Up to this point there is no difficulty whatever in following the order in which these coals lie. The strata follow each other with surprising regularity, seldom varying more than 10 yards in thickness between the same coal-seams.

About a mile and a half to the north-east of Bacup one of the large faults passes in a north-westerly direction, causing some alteration, and at the opposite side of that the principal coal of the Gannister series is known at Cliviger and all round the northern part to Colne as the "mountain four feet," and it is there generally accompanied by an unusually large number of very fine specimens of Goniatites and other fossil remains.

Returning to the south-west side of the large fault, between Bacup and Cliviger, the Gannister coal, which was at Bacup 4 feet thick, becomes much thinner in a westerly direction.

At Over Darwen the Gannister coal is called the "lower," "70 yards," or "half-yard" bed. The principal seam above it is there known as the "yard coal," which, together with the "little coal" above it, corresponds with the "40-yards" seam. The flag and tile-rock of Darwen lies about 40 yards above the "yard coal." The strata, about 10 yards in thickness, which separate the "little coal" from the "yard coal," at Darwen, gradually thin out in the direction of Hoddlesden. At the old Hoddlesden Colliery the two seams were found gradually approaching each other until they came so near as to be worked together; and now, where they are being worked, there is only a division of black earth between, the rock being entirely nipped out. They continue together as one seam for some distance, but ultimately they divide out again, and at Belthorn the upper part is called the "half-yard," and the lower the "little coal." At Brookside and Duckworth Hall they again lie together, and are called the "Poor Robin" bed. At Chorley, and also at Heath Charnock, the corresponding coals are known as the "little" and the "higher mountain." At many of those places this "little" coal has a rock floor, which has often been mistaken for the true Gannister.

The total thickness of the strata between the Gannister coal and the Arley mine is, at Oldham, about 300 yards. At Simpson Clough it seems to be thinner than at any other point, being only about 253 yards. At Clayton, the distance is about 308 yards from the Arley to the Gannister. Adding to this the total thickness of strata in which coal-seams are found below the Gannister, namely, 326 yards, as shown at Mossley and Hartshead, gives a total thickness of about 625 yards of coal-bearing strata in the lower or Gannister series alone.

The middle series, from the Arley mine to the Worsley four-feet, is about 975 yards in thickness. The upper series, above the Worsley four-feet, has been proved at Patricroft to a thickness of 390 yards, but this is not the whole of it, and including the measures at Clayton, near Manchester, it is about 550 yards in thickness. The total thickness of coal-measures in the upper, middle, and lower series, to the lowest coal-seam, is therefore about 2150 yards, exclusive of the grits and limestone shales below.

In the middle series there are a large number of seams, and the field is divided into many divisions by main faults—the largest extending to a thousand yards of vertical displacement or throw.

The part known as the Burnley coal-field is not a detached portion, as is sometimes supposed and laid down on maps, but is connected with the main field by the lower strata up to the Gannister coal. The southern boundary, of what may still for convenience be termed the Burnley coal-field, is a remarkable fault, which runs nearly due east and west instead of north-west, like nearly all the other principal faults. At the eastern end this fault crosses the valley between Calder Head and Holme; it then passes Thieveley, where it has been worked for lead ore; then on to Burnt Hills, near Clawe Bridge, where lead ore has also been found in it, and also at Cupola, a name derived from the furnace formerly used for smelting the ore which was then worked. The fault then continues westwards through the town of Church to the south of Rishton. For the most part of its course it consists of two faults, which are sometimes near together and sometimes run from 500 to 700 yards apart. The northern one is a downthrow to the south of about 70 yards, and the southern one a downthrow to the north of about 250 yards, forming a trough or deep belt between. The two faults taken together may be looked upon as a great anticlinal division. The strata on the south side dip for the most part at a slight angle southwards into the main coal-field; and on the north side they dip to the north, forming the Burnley coal-field.

The contour of the Burnley coal-field forms nearly half a basin. The north-western outcrop is very steep, the dip being nearly at an angle of 45°, and is called the "rearers." Like other parts of the Lancashire coal-field, the Burnley basin is divided by large faults, most of which have a direction 35° west of true north. By these faults it is divided into six separate main divisions, in each of which the Arley four-feet coal has been found near the centre.

In the Altham basin, the Hapton basin, and in the Habergham basin, the Arley mine is worked.

In the fifth, or Burnley basin of the Burnley coal-field, the Arley mine extends over a large area. It is there where the greatest depth of strata in the Burnley basin are found.

Sixth, and last, is the Marsden basin, where the Arley mine is also worked. This basin extends to near Colne, where the mountain four-feet is now being worked. The bedding of the strata in these six divisions of the Burnley coal-field is more laminated, or flaggy, than at most other parts of the Lancashire coal-field.

At Clayton and Bradford, on the east side of the city of Manchester, the coal strata are apparently surrounded by "red rock," which disconnects the upper coal-seams from those at Pendleton and other places.

At Patricroft, and Bedford, near Leigh, thin limestones are also met with; but they are not stratified with the coal-measures, and are classed with "red-rock" (Permian) strata, which here overlie the coal-measures.

The paper is illustrated by a remarkably fine section of the beds, more than 6 feet in length, giving the name and thickness of every stratum and seam.

Another paper was read "On some horses' teeth, and a supposed worked flint found in the drift at Barrowford, near Burnley," by Mr. J. Whitaker. In the wider parts of the valley the Boulder clay is covered by three or four yards of gravel, on the top of which lies sand about two feet thick, covered by three feet of fine sandy soil, the whole resting on the millstone-grit series of rocks. The teeth were found during the cutting of a trench across the widest part of the valley, and were embedded in the gravel, six feet below the surface. They belong to the genus *Equus*. The flint was picked out from amongst the materials thrown out of the trench.

Geological Society.—*May 20th*, 1863.—1. "Further Observations on the Devonian Plants of Maine, Gaspé, and New York." By J. W. Dawson, LL.D., F.R.S., F.G.S.

Since the preparation of his paper on the Devonian Flora of North-Eastern America, published in the Society's Journal, vol. xviii. pp. 296 *et seq.*, the author has been enabled to explore more thoroughly than before the plant-bearing beds of Perry, in Maine, Gaspé, and New York. The results of these further explorations, together with descriptions of the new species of plants discovered, were given in this paper; as also were some new and important facts respecting the distribution of the Devonian rocks of the State of New York, which give to several of the plants from that region a somewhat older geological position than that heretofore assigned to them.

2. "Notice of a New Species of *Dendrerpeton*, and of the Dermal Coverings of certain Carboniferous Reptiles." By J. W. Dawson, LL.D., F.R.S.

This paper referred to new facts ascertained in the course of a re-examination of the remains of reptiles from the Coal-formation of Nova Scotia, and first to the characters of a new and smaller species of *Dendrerpeton*, for which Dr. Dawson proposed the name of *D. Oweni*. The author then described the remains of skin and horny scales which he had lately discovered, and which he supposed to belong to *Dendrerpeton Oweni*, *Hylonomus Wymani*, and *H. Lyelli*. He also gave restorations of these animals, according to what he regarded as the more probable arrangement of the parts; and, after expressing his belief that *Hylonomus* may have Lacertian affinities, he stated that should they prove to be really Batrachian, a new Order must be created for their reception, many of the characters of which would coincide with those of the humbler tribes of lizards.

3. "On the Upper Old Red Sandstone and the Upper Devonian Rocks." By J. W. Salter, Esq., F.G.S., A.L.S.

The conclusions arrived at by Mr. Salter were based upon certain sections in Pembrokeshire, Devonshire, and the North and South of Ireland, which he described in full, and compared with one another as well as with the Upper Devonian of the Continent and America, giving lists of fossils from the English localities. The sections in Devonshire and South Ireland were contrasted with those in Pembrokeshire and North Ireland; and it was shown that, although the physical features in the two cases very nearly correspond, the Marwood series is constant, and the Pilton group of the former districts is a series unknown in Pembrokeshire, or only represented by beds, a few feet thick, at the base of the Carboniferous slate. The author endeavoured further to prove the intercalation of marine beds in the Upper Old Red Sandstone, and, by the fossils, the correlation of the Marwood group of Devonshire with the uppermost part of that series. He stated his belief in Sir R. I. Murchison's suggestion, that the Caithness Flags belong to the Middle, and the Cephalaspis Beds of Scotland to the Lower Old Red, which divisions he considered equivalent to the Middle and Lower Devonian respectively; and concluded by assigning the Tilestones (or Ledbury shales) to the Lowest Devonian.

June 3rd.—"On the Section at Moulin-Quignon, and on the peculiar character of some of the Flint Implements found there." By J. Prestwich, Esq., F.R.S., F.G.S.

The recent discovery of a human jaw and of flint implements of a peculiar type and fresh appearance at Moulin-Quignon has led to questions having been lately raised as to the age of the gravel-beds, and the antiquity of these remains. Mr. Prestwich showed how conflicting had been the evidence in support of the views formerly entertained, and dwelt upon the appearances which had raised the doubts as to the genuineness of certain implements and the fossil nature of the jaw. He also gave a *résumé* of the proceedings of the conference lately held at Paris and Abbeville, and remarked that the intrinsic evidence appeared to prove the spurious nature of the objects, while the evidence derived from the study of the beds had led to the opposite conclusion.

The author then showed that, from the physical configuration of the district, corroborated by the presence of extinct mammalia distinctly of contemporaneous age, the modern age assigned to these beds by some geologists could not be maintained; and that, from the occurrence of freshwater shells in both the high- and low-level gravels, their formation must have been due to river-action, and not to a wave of translation or other modification of marine action.

Mr. Prestwich concluded by stating that, whatever may be the conclusions drawn from the jaw and the flint-implements, the age of the deposits is to him perfectly well determined as being of the early quaternary or post-pliocene period, older than the Menchecourt gravels, and anterior to the excavation of the valley of the Somme; and as some flint-implements, the genuineness of which is not doubted, have been found in these deposits, the question of the antiquity of man will not be affected, whatever the conclusions arrived at with regard to certain others.

The following specimens were presented:—

Cretaceous fossils from Ras Fartak, on the south-east coast of Arabia; fossils from the Somali Mountains, collected by Messrs. Burton and Speke; fossils from the north bank of the river Nerbudda; and Tertiary fossils from Travancore, by Dr. H. J. Carter, F.R.S; fossils from the Valley of Kelat, by Dr. Cook, of H.M. Bombay Army.

NOTES AND QUERIES.

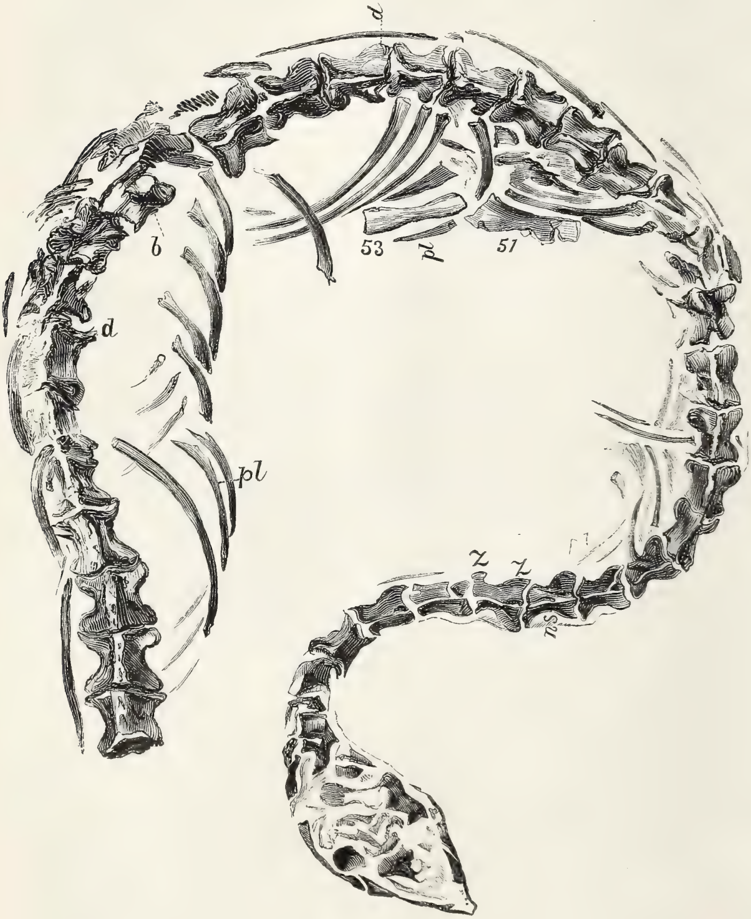
New Ossiferous Cavern.—Sir Lawrance Palk, Bart., M.P., has placed a limestone cavern, recently discovered on his property at Torquay, under the care of Mr. Pengelly, who has undertaken to explore it.

[Bones are numerous, and the highest interest will undoubtedly attach to the results of the exploration in Mr. Pengelly's able hands.—Ed. Geol.]

Roots of Lepidodendron.—At page 107 of the April number of the 'Geologist' for the year 1861, which has just fallen into my hands, it is there stated by Mr. Salter, in his lecture on Coal, that he believes Halonia to be the root of Lepidodendron. I have had in my possession for about three years a good specimen of Lepidodendron, with roots of Halonia attached, which puts the matter beyond a doubt. It may also be pleasing to those geologists to inform them that I shall take an especial interest in showing it.—James Wild.

Pleasant Spring, Red Tan Nook, Oldham, May 30th, 1863.

The Reptiles of the Chalk.—The reptiles of the Chalk, although they are not so abundant or so varied in that formation as reptilia are both in forms and numbers in the Liassic and Oolitic beds, nor so grand,



DOLICHOSAURUS LONGICOLLIS.

From the Lower Chalk of Burham, Kent.

[In the Collection of Mrs. Smith, of Tunbridge Wells.]

S. J. Mackie del.

perhaps, as those of the Wealden age, are nevertheless an extraordinary class amongst the fossils of that later period.

Of Chelonians, we have the beautifully-preserved *Chelone Benstedi*, exhibiting the whole of the carapace and a considerable portion of the plastron; but although we have the body, nobody, as far as I know, has ever found the head of this or any other Chalk-turtle. As we may infer that turtles in those times were not headless, we may hope that collectors in Chalk districts will use their endeavours to find some of the heads our Chalk-turtles have lost.

Besides the *Chelone Benstedi*, there have been found in the Chalk, portions of the large species of turtle recorded by Camper as occurring in the Maestricht beds,—the *Chelone Camperi* of Owen. Indeterminate fragments of other species have been also noted in Professor Owen's 'Memoir.'

Of the Lacertilia, we have from the Lower Chalk of Cambridge, Maidstone, and Northfleet, the *Raphiosaurus subulidens* (*R. lucius* of Dixon); the *Coniosaurus crassidens*, from Clayton, Worthing, and Charing, and the railway cutting between Brighton and Lewes; the *Dolichosaurus longicollis*, from Burham, a strange, small, wonderfully long, thin form, of which only one specimen is known, one head and upper moiety being in the collection of Mrs. Smith, of Tunbridge Wells, and a second portion, containing the posterior, abdominal, and sacral vertebræ, with portions of the hinder limbs, in the collection of Sir Philip Egerton.

Then of the swimming lizards we have the great Mosasaurus, some species attaining a length of 25 feet, a genus made ever famous by the Canon Goddin's specimen, captured by the French at the siege of Maestricht. The British chalk-beds have yielded various portions of *M. gracilis*, chiefly from Sussex and Kent. Another mosasauroid form, the *Leiodon anceps*, has been found in a chalk-pit in Essex and in the Brighton railway-cutting near Lewes.

Of crocodiles, the English chalk—for it is of this English chalk we are now solely speaking—has yielded *Polyptychodon interruptus* in the Chalk-marl; *P. continuus*, Lower Chalk; *Plesiosaurus Bernardi* in the Lower Chalk of Dover; *P. constrictus*, from Steyning, in Sussex; and some other remains, possibly of other species, in the Chalk of Kent and Sussex; *Ichthyosaurus campylodon*, from the cuttings in the Grey Chalk for the Dover Railway, and from the Upper Greensand of Cambridge.

Of the strange Order Pterosauria, or winged reptiles, abundant remains have been found in the Kentish chalk, chiefly at Burham, on the hillside of the Medway valley. The nature of these remains was first established by Dr. Bowerbank, for previously they had been more or less doubtfully assigned to birds. A large fossil wing-bone of *Pterodactylus giganteus*, from the Middle Chalk of that locality,—sometimes erroneously referred to as that of an albatross,—was figured, in 1845, in the Proceedings of the Geological Society by him; and in the same paper, characteristic jaws and teeth, and various bones of other species were briefly noticed.

The expanse of wing of this Pterodactyle was estimated, from the proportions of Goldfuss' *P. crassirostris*, at least 9 feet. Another gigantic flying reptile, *P. Cuvieri*, was exhibited by the same geologist before the Zoological Society in 1851. The specimen was a portion of jaw without any traces of nasal perforations, 7 inches in length; and Professor Owen estimates the entire skull at close upon 2½ feet in length. The *P. conirostris* of Owen, in Dixon's 'Geology of Sussex,' is a synonym of Bowerbank's *P. giganteus*. Another species, from the Middle Chalk of Kent, also in Dr. Bowerbank's collection, has been described by Professor Owen, —*P. compressirostris*.

The great Dinosaurian lizards have not been met with higher than the Greensand beds,—unless a large undetermined bone in the Folkestone Town Collection, collected by the author, should prove to belong to some great Iguanodon.

To these notes which we have made in the hope of drawing the attention of collectors, at this genial season, and of gathering information of new or unrecorded specimens, in private cabinets and local museums, we may usefully add a record of the specimens in the British Museum. These are in the table-cases:—Femur of *Trionyx ?*, from the Chalk of Rochester, collected by Mr. Bensted (and figured in 'Geologist,' Vol. V. p. 296); two large teeth of *Polyptychodon ?*, with fragments of cellular bone, from the Grey Chalk of Dover?; jaws, loose teeth, humerus, vertebræ, wing, and bones of Pterodactyles, from Upper Greensand of Cambridge; and a portion of very large wing-bone of Pterodactyle, from the Gault of Folkestone; beaks and other bones of *Chelone altimentum*, *Chelone depressimentum*, and possibly of other Chelonians, from the Upper Greensand of Cambridge; very fragmentary tooth, without the enamel, of perhaps *Pliosaurus ?*, from the Lower Chalk of Sussex (Mantell Collection); teeth of species of Plesiosaurus, from the White Chalk of Southerham, Sussex, and the Wealden of Tilgate Forest; teeth of *Ichthyosaurus campylodon*, from the Chalk of Islesham, and Lower Grey Chalk of Dover; also some from the Gault of Folkestone, and Upper Greensand of Cambridge, from which last deposit are also some worn vertebræ; teeth of *Polyptychodon interruptus*, from the Sussex White Chalk (Dixon Collection), the White Chalk of Rochester, Kent; from Steyning, in Sussex (Mantell Collection); (? sp.) two specimens in hard chalk, from Kent (Taylor Collection); (? sp.) from the Folkestone Gault; and numerous teeth from the Upper Greensand of Cambridge. From the Wealden, *Suchosaurus cultridens*, Owen, Tilgate Forest (Mantell Collection); *Goniopholis crassidens*, Owen, Tilgate Forest, Sussex (Mantell Collection); *Coniosaurus*—jaw and isolated teeth of *C. crassidens*, Owen, from the Chalk of Washington, near Worthing (Dixon Coll.). In the Saurian wall-cases are fine jaws with teeth and large vertebræ of *Ichthyosaurus campylodon*, Carter, from the Grey Chalk of the Round Down Tunnel, on the South-Eastern Railway, near Dover; and teeth and vertebræ of *Icthyosaurus campylodon ?*, from the Cambridge Upper Greensand; vertebræ of a Wealden *Plesiosaurus* in sandstone from Tilgate Forest (Mantell Coll.).

Of Chelonians in the wall-cases are the fine remains of *Chelone Benstedi*, found in the Lower Chalk of Burham by Mr. Bensted, and given by him to Dr. Mantell, and some fragments from the Chalk of Lewes and Rochester; numerous remains of *Chelone Mantelli*, from the Wealden of Tilgate Forest (Mantell Coll.); and of *Platemys Dixoni*, Owen, from the same locality (Mantell Coll.).

Of the Great Lacertians in the wall-cases are a fine fragment of upper and lower jaws, with teeth, of *Mosasaurus gracilis*, Owen, from the Lower Chalk of Burham (Taylor Coll.); two vertebræ of the same species from the Upper (?) Chalk of Lewes; and isolated teeth of Mosasaurus (sp. ?) from the Norwich Chalk (Mantell Coll.); and the Egerton specimen of *Dolichosaurus longicollis*, from the Grey (not Lower White) Chalk of Kent.

We would here only add that the species of which, more than any other, it is particularly desirable to get further evidence, both as to its nature, size, and geological zone, is the *Dolichosaurus longicollis*, of the specimen of which in Mrs. Smith's collection we give a figure in Plate XIV.

S. J. Mackie.

The Mines of Tuscany.—The working of mines in Tuscany dates from the earliest antiquity, having exercised an important influence on the history and social economy of the ancient Etruscan people; and evidence of ancient workings, assignable to Etruscan, Roman, and mediæval ages, have been often encountered in modern explorations. In the late International Exhibition, M. Hauft, of Florence, exhibited a series of plans and synoptical tables illustrating this subject. Amongst these were special plans, on a scale of three inches to a mile, showing that the mineral veins, fumerolas, brine-springs, and lines of volcanic activity, have a remarkable amount of parallelism, and form two great groups, the intersections of which are the chief seats of mining enterprise. This double parallelism has also been observed to exist in the mining region between the Apuan Alps and Mount Amiata. The average direction of the first group is N. 3° W.; the extremes lying between N. 28° W., and N. 11° E., or a total variation of 39°. The mean direction of the second group is N. 54° W.; the extremes N. 67° W., and N. 45° W., or 22° of variation. The direction of the brine-springs is N. 46° W., the variation being 7° on either side. The course of the deposits of alum worked at Montione and Frassine is similar to the salt group, viz. W. 50° E.; the fumaroles, whose vapours contain boracic acid, are arranged in four series, having a mean direction of N. 47° W., with a variation on either side of 5½°. Two other lines of fumaroles have a direction N. 12° E., which coincides with the strike of the four great deposits of iron ores existing in the island of Elba. The lines of strike passing the marble quarries near Seravezza, give directions N., and N. 53° W. The direction of a line passing the mines of Montieri, Gerfalco, and Poggio Matti, N. 48° W., or parallel to the line of the subterranean fires of Mount Oggioli, Pietramala, and Peglio. The directions of the three gigantic metalliferous lines of the district of Massa are N. 13° W., N. 11° W., and N. 3° W., while that of the deposit of alum at Accessa, Monterotondo, and Sasso is N. 7° W. All the above lines of bearing are included between the directions N. 28° W., and N. 12° E. in the one case; and between N. 67° W., and N. 46° W. in the other,—an amount of variation so small, that M. Hauft has concluded that in Tuscany the various metalliferous deposits, as well as those of alum and sulphur, the brine-springs, and the various volcanic emanations, are all different phases of one great formation, due to causes still in active operation in the production of borax, petroleum, sulphur, etc. This formation is, he says, divisible into two periods of unequal value, as far as minerals are concerned, for many of the veins contain no metalliferous substances, and it is only in a few of the metalliferous deposits of the Maremmana formation that silver ores occur. The above conclusion is verified, he considers, by other coincident circumstances. The two lines which unite the extreme points in the salt districts, and include the four principal series of boracic acid, *soffioni*, are parallel to one of the leading lines of mineral veins; the line passing through the fumaroles of Lucignano and Serrazzano, combines exactly with that uniting the saline springs of Fontebagni, Loriano, and Scornellina; while, in like manner, the line joining the fumaroles of Monterotondo and Sasso coincides with the line of salt-springs rising between Fattagliana and Prugnano. This relation between the most important borax districts and the metalliferous country of Tuscany has led to the supposition that they may be regarded as in some sort a continuation of the latter. In addition to these cases may be added the occurrence of borax and alum at Sasso and Monterotondo, and the association of alum deposits with mineral ores at Accessa, both of which are in direction N. 12° W. In the same manner, the fumaroles of the lake of Monterotondo correspond, on the line of N. 49° W. with the mines of Cugnano, and in the direction W. 3° E.

with the copper veins of Serrazzano. Throughout the whole of Tuscany the most productive mineral region is that of the borax lagoons. On the north-west portion of this area copper ores are found, occurring in veins of serpentine rocks. Further towards the south, mines of copper and argentiferous lead are worked, principally in the Macigno formation, which is also the chief repository of the borax. By thus tracing a series of lines through all the points at which minerals occur, M. Hauft claims to have established the limits and subdivisions of each district. In this way many gaps are seen to occur in some places, and these, M. Hauft thinks, indicate that many mineral mines must be still unknown, as, for instance, in the mountains of Lucca and Pisa; for the exploration of these unexamined districts, the application of the indications of other mineral zones should be of considerable utility, and it is reasonable to suppose that new deposits would be found in the prolongation of known areas, or in their immediate vicinity. In like manner it has been suggested that, by attention to this principle, aided by the records of history, the rediscovery of the old Etruscan mines may also be possible.

MAMMALIAN, CETACEAN, AND HUMAN REMAINS.—The following notes, made in reading various old authors, may prove interesting and useful in present investigations of mammalian, human, and other remains.—S. J. MACKIE.

From the NATURÆ GAZOPHYLACIO penes JOANNEM HIERONYMUM ZANNICHELLI. Venetiis. Index primus, quo Fossilia figurata recensentur. Venetiis, 1726.

Tabula quinta, p. 23 *et seq.*—

25. Dens Hippopotami fossilis, ex rivo dicto *della Salsa*, prope Saxolum, in ditione Mutinensi.

31. Ossa humana fossilia, ex ditione Palatina, in Germania.

42. Frustum mandibulæ Elephantis fossile, ex agro Romano.

*43. Lapis frumentarius, seu juxta Langium, semen fœniculi, ex agro Veronensi.

48. Unguis Bovis in lapidem concretus, ex monte prope Cenetiam.

Tabula octava, p. 43 *et seq.*—

27. Cornu Capræ fragmentum, simul cum ungula in saxo, ex ditione Cenetensi.

Tabula nona, p. 49 *et seq.*—

26. } 27. } Dentes Draconum, ex Saxonia.

Series altera, Fossilium figuratorum ingentis magnitudinis, p. 53 *et seq.*

3. Dens molaris minor Elephantis fossilis, ex agro Romano.

10. Costæ Balenæ fossilis frustum, ex montibus Norvegiæ.

52. Dens incisorius Elephantis, summæ duritiei, ex agro Romano.

58. Dens molaris maximus Elephantis, agri Romani.

133. Ungula Bovis fossilis, ex agro Cenetensi.

139. Dens Draconis, seu potius ingentis Ceti, ex monte Carpatio.

148. Ungula Bovis minor fossilis, ex Cenetensi agro.

155. Dentes cujusdam animalis terrestris, saxo rubiginosi coloris incerti, ex Dalmatia.

*169. ? Lapis piriformis, ex agro Veronensi.

194. Calvaria Hominis cum suis dentibus, una cum osse humeri, fossilis et in lapidem concreta, ex ditione Istriæ.

202. Linguæ Bubulæ fossiles, ex specu Behumaniana, seu potius dentes minores Elephantum.

Sunt et alia quamplurima, omissa in hoc indice, imposterum tamen, cum opportunum videbitur, addenda.

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* Can this be possibly a large flint-implement ?—ED. GEOL.

Many of these entries are repeated in the latter catalogue of Zannichelli's collection, entitled—

ENUMERATIO RERUM NATURALIUM quæ in Musæo Zannichelliano asservantur. Venetiis, 1736.

Musæi Zannichelliani abacus alter (p. 30 *et seq.*), in quo fossilia figurata continentur.

3. Dens molaris minor Elephanti fossilis, ex agro Romano.
10. Costæ Balenæ fossilis frustum, ex montibus Norvegiæ.
52. Dens incisorius Elephanti, summæ duritiei, ex agro Romano.
58. Dens molaris maximus Elephanti, agri Romani.
88. Musculus lapideus aliisque Crustaceis minoribus unitus, ex agro Veronensi.
133. Ungula Bovis fossilis, ex agro Cenetensi.
139. Dens Draconis, seu potius ingentis Ceti, ex monte Carpatio.
148. Ungula Bovis minor fossilis, ex Cenetensi agro.
155. Dentes cujusdam animalis terrestris, saxo rubiginosi coloris incerti, ex Dalmatia.
194. Calvaria Hominis cum suis dentibus, una cum osse humeri, fossilis et in lapidem concreta, ex ditione Istriæ.
202. Linguæ Bubulæ fossiles, ex specu Behumaniana, seu potius dentes minores Elephantorum.
208. Dens maximus Elephanti fossilis, optimè conservatus.

Fossilia figurata in abaci inferiore parte reposita (p. 51 *et seq.*).

Tabula quinta.—

25. Dens Hippopotami fossilis, ex rivo dicto *Salsa*, prope Saxolum, in ditione Mutinensi.
31. Ossa humana fossilia, ex ditione Palatina, in Germania.
42. Frustum mandibulæ Elephanti fossile, ex agro Romano.
48. Unguis Bovis in lapidem concretus, ex monte prope Cenetam.

Tabula octava, p. 87 *et seq.*—

62. Ungula Hircina, in lapidem concreta, ex Cenetensi ditione.

Tabula nona, p. 93 *et seq.*—

$\left.\begin{array}{l}26.\\27.\end{array}\right\}$ Dentes Draconum, ex Saxonia.

GEOLOGY OF THE GOLD-FIELDS OF AUCKLAND, NEW ZEALAND.—Dr. W. Lauder Lindsay, who made a geological examination of the Coromandel gold-field, in the province of Auckland, in February, describes Coromandel as a different type of gold-field from Tuapeka (Otago), and, as such, of interest as illustrative of the general geology of the New Zealand gold-fields. The main results of his observations and deductions may be concisely stated thus:—

The geology of the northern gold-fields of New Zealand, including those of Nelson as well as Auckland, does not differ essentially from that of the southern or Otago gold-fields (the geology of the latter is described in this volume, p. 143). The parent slates, for instance, are in the north more frequently of a clay-slate or argillaceous character than in the south; the auriferous quartzites are frequently developed to an extent as yet unknown in Otago; the evidences of trappean disturbance are more numerous, and the metamorphism of the slates by the contiguity of the erupted or intruded traps better marked. Nor does the character of the gold differ materially, save in so far as, in certain localities, it is more generally associated with its quartz matrix.

The Coromandel peninsula consists mainly of a mountain ridge, running nearly north and south; the mountains having a bold serrated outline, and varying in height from 1000 to 2000 feet. The valleys between the spurs given off laterally by this main or dividing range are of the character generally of ravines or gorges, occupied by mere mountain-streams; the "flats" or alluvial tracts at their mouths, and on the coast, are inconsiderable.

This mountain-range consists apparently of slates of Silurian age, generally of argillaceous character, but greatly altered by contact with, or proximity to, numerous outbursts or intrusions of trappean and other rocks. The mountains are so densely wooded, and so difficult of access, that it is only here and there in the gorges of the streams that sections of these slates may be examined. In these sections the slates are frequently found to resemble Lydian stone or the slaty varieties of basalt, such as clinkstone; while they are disposed more or less vertically, their irregular upturned edges affording the most convenient and abundant "pockets" for the detention and storage of the alluvial gold washed from the higher grounds.

Local geologists describe the fundamental rock of the Coromandel mountain-system as granitic, and the granite as forming here and there the "aiguilles" of the dividing ridge; but Dr. Lindsay met with no granite *in situ*, nor did he discover granitic boulders or pebbles in the boulder-clays of the auriferous drift, nor in the shingly beds of the mountain streams about Coromandel Harbour.

The Coromandel slates are characterized by their prominent and numerous quartz "reefs," consisting of auriferous quartzites. Here and there, where the dense vegetation admits, these reefs are met with *in situ*, frequently as "dykes," standing prominently above the general level of the slates; sometimes forming the top of the dividing ridge itself. The proximity and abundance of such quartzites are sufficiently indicated by the immense numbers of huge quartz-boulders or blocks which bestrew the low ground, and occupy the ravines and gorges; which blocks are characterized by comparative angularity. The quartz is frequently of the porous, light, spongy character so prevalent in the gold-fields of Australia, Nova Scotia, California, and other auriferous countries; and its colour is frequently buff, brown, ochrey, or vermilion, the result, apparently, of different degrees of ferruginous impregnation.

The auriferous drift is mostly of the character of the newer or upper Tertiary drifts of the Otago gold-fields, consisting essentially of—*a*. variously-coloured clays; *b*, boulder-clays, also variously coloured; and *c*, gravels, of the "chopped slate" character, the débris of the component rocks of the parent ranges, which gravels rest immediately on the "bed-rock" or slate. In this gravel, as at Otago, the gold chiefly occurs; hence to these gravels are, as yet, mainly directed the operations of the miner. The gold itself occurs in the form of dust, scales, or nuggets—frequently as scaly nuggets or "pepites," but still more generally dendritically disseminated in quartz-pebbles, which are usually ochrey or brownish in colour. It is largely associated with iserine (titaniferous iron-sand), apparently of the character of that so abundant at Taranaki. This mineral, indeed, appears to be associated with gold in almost all the New Zealand gold-fields.

The prevalent volcanic rocks, which burst through, overlie, or are otherwise associated with the slates, are mainly various trachytes, tuffs, basalts, and syenites. A hard breccia, consisting to a great extent of fragments of jasper and flint, resembling somewhat the "cement" or quartz conglomerate of the older or lower Tertiary auriferous drifts of the Otago gold-fields, occurs on Beeson's Island, in Coromandel Harbour, which island is mainly or altogether tufaceous. Boulders of basalt and syenite bestrew the tops of the hills which form the greater part of the said island; and basaltic boulders are associated with quartzose ones in the shingly beds of the mountain streams of Coromandel and in the boulder-clays of the auriferous drift.

Contrasting the Tuapeka (Otago) with the Coromandel gold-fields, the author indicates the following respective peculiarities: — At Tuapeka (Otago):—*a.* The bare open country, resembling the Lammermuirs of Scotland, consisting of gently undulating "ranges," of a height generally of from 500 to 1500 feet. *b.* The abundance of the auriferous drift, and the comparative insignificance or scarcity of the parent quartzites. *c.* The scarcity of timber for fuel and slabbing; but, on the other hand, the presence of lignites. *d.* The inclement climate. *e.* The difficulties of land-communication with the capital, Dunedin, arising from insufficient roads. *f.* Unlimited powers of "prospecting" and "working," arising from the absence of a native population. At Coromandel:—*a.* The precipitous mountain-ranges, densely covered with a jungle-vegetation to the top; the hill-bases impinging directly on the sea-margin, without the intervention of "flats," save to an insignificant extent. *b.* The scarcity of the auriferous drifts, and the abundance of the parent quartzites. *c.* The abundance of timber for fuel, mining-works, and dwellings. *d.* The superior climate, arising from its geographical position, 800 miles more northerly. *e.* The facilities of water-communication with the capital, Auckland, 45 or 50 miles distant. *f.* Difficulties and dangers of prospecting and working, arising from the presence of a jealous, hostile proprietary native population.

From his observations at Coromandel and Tuapeka, as well as in the other parts of New Zealand visited during his tour of 1861–62, Dr. Lindsay makes the following statements, inferences, or predictions:—

1. That while there is, at Coromandel, a very limited and insignificant field for *alluvial digging*, there is ample scope for *quartz-mining*. 2. That the auriferous resources of Coromandel will only be fully developed in the course of many years by the application of all modern improvements in chemistry and mechanics to *systematic mining*, which must become one of the permanent industrial occupations of the province of Auckland, and which will demand the sinking of a large capital in the first instance. 3. That slates similar to those of Coromandel, with associated auriferous quartzites, will be found to occur over a comparatively large area of the province of Auckland. 4. That new gold-fields remain to be discovered in that province; though experiment only, and on a suitable scale, can determine where and whether "payable" gold-fields exist. 5. That whereas *lignites* are widely distributed over the province of Auckland, it is most desirable to ascertain whether they are of similar geological age to those of Otago, and associated with the same auriferous drifts. 6. That whereas, in Australia and other auriferous countries, gold is not confined necessarily to metamorphic slates or their derived drifts, but occurs occasionally in granitic and hornblendic (syenitic) rocks or their débris; and whereas, though this is rare in New Zealand, there is, according to the testimony of Mr. Haast, the Government geologist of the Canterbury province, at least one good instance of such an occurrence in the province of Nelson, in the beds of the rivers Roto-iti and Roto-roa, where the gold could apparently only have been derived from the decomposition or degradation of rocks of a syenitic or hornblendic character,—the attention of prospectors and miners, not only in the province of Auckland, but in that of Otago, and, indeed, in all the New Zealand provinces, all of which will probably be found to be to a greater or less extent auriferous, should be directed to

drifts derived from granitic and hornblendic rocks, as well as to those resulting from the detrition of Silurian and other slates. 7. That it is probable the auriferous system of rocks, the supposed Silurian slates, extends from the province of Otago into the adjacent provinces of Southland and Canterbury; from Nelson, where they are already known to exist to an extent second only to that in Otago, and where, indeed, "gold-fields" have been successfully worked for a considerably longer period, in Canterbury; and from Auckland into Wellington and adjacent districts, though to what extent remains to be determined by actual survey and experiment. 8. Contrasting the Northern with the Middle Island of New Zealand, it is probable that the latter is more extensively and largely auriferous than the former; that in the former the auriferous quartzites are developed out of proportion to the derived drifts, while in the latter the reverse is the case; and that, should this supposition prove to be correct, the character of the gold-mining in the two islands will necessary differ most materially. 9. Speaking in general terms, auriferous rocks may be said to extend throughout the New Zealand islands, the exceptions being where they are interrupted by recent volcanic formations, traps of various ages, mostly Tertiary, limestones of various ages, extensive Tertiary beds, and other geological series or systems.

Dr. Lindsay strongly advocates an immediate systematic *geological survey* of the province of Auckland, estimating its duration at about five years, with an expenditure on staff, travelling, and publications of about £10,000. He recommends this equally for all the New Zealand provinces of which geological surveys have not yet been made; pointing to the example of Otago, which has recently appointed a Government geologist, who is now engaged on a three years' survey of that most interesting province.

WREN'S SECTION AT ST. PAUL'S.—The account of the geological section presented in the excavation of the foundations of St. Paul's may be worth a record here. It is from 'The Parentalia,' published by Sir Christopher Wren's son, in 1750:—

"It has been before observed that the graves of several ages and fashions, in strata or layers of earth one above another, particularly at the north side of St. Paul's, manifestly showed a great antiquity from the British and Roman times, by the means whereof the ground had been raised; but, upon searching for the natural ground below these graves, the surveyor observed that the foundation of the old church stood upon a layer of very close and hard pot-earth, and concluded that the same ground which had borne so weighty a building might reasonably be trusted again. However, he had the curiosity to search further, and accordingly dug wells in several places, and discovered the hard pot-earth to be, on the north side of the churchyard, about six feet thick and more, but thinner and thinner towards the south, till it was, upon the declining of the hill, scarce four feet; still he searched lower, and found nothing but dry sand, mixed sometimes unequally, but loose, so that it would run through the fingers. He went on till he came to water and sand, mixed with periwinkles and other sea-shells; these were about the level of low-water mark. He continued boring till he came to hard beach, and still under that till he came to the natural hard clay which lies under the city and country, and Thames also, far and wide. By these shells it was evident the sea had been where now the hill is on which Paul's stands. The surveyor was of opinion the whole country between Camberwell hill and the hills of Essex might have been a great frith or sinus of the sea, and much wider near the mouth of the Thames, which made a large plain of sand at low-water, through which the river found its way; but at low-water, as often as it happened in summer-weather, when the sun dried the surface of the sand and a strong wind happened at the same time, before the flood came on, the sand would drive with the wind and raise heaps, and in time large and lofty sand-hills; for so are the sand-hills raised upon the opposite coasts of Flanders and Holland. The sands, upon such a conjuncture of sunshine and wind, drive in visible clouds; this might be the effect of many ages before history, and yet without having recourse to the flood. This mighty broad sand (now good meadow) was restrained by large banks still remaining, and reducing the river to its channel; a great work, of which history gives no account. The Britons were too rude to attempt it; the Saxons too much busied with continued wars; he therefore concluded it was a Roman work: one little breach in his time cost £7000 to restore. The sand-hill at Paul's, in the time of the Roman colony, was about twelve feet lower than now it is; and the finer sand, easier driving with the wind, lay uppermost, and the hard coat of pot-earth might then be made; for pot-earth, dissolved in water and viewed by a microscope, is but impalpable fine sand, which with fire will vitrify; and of this earth upon the place were those urns, sacrificing vessels, and other pottery-ware made, which, as noted before, were found here in great abundance, more especially towards the north-east of the ground.

"In the progress of the works of the foundations the surveyor met with one unexpected difficulty. He began to dig the foundations from the west end, and had proceeded successfully through the dome to the east end, where the brick-earth bottom was yet very good; but as he went on to the north-east corner, which was the last, and where nothing was expected to interrupt, he fell, in prosecuting the design, upon a pit where all the pot-earth had been robbed by the potters of old time. Here were discovered quantities of urns, broken vessels, and pottery-ware of divers sorts and shapes. How far this pit extended northward there was no occasion to examine: no ox-skulls, horns of stags, tusks of boars, were found to corroborate the accounts of Stow, Camden, and others; nor any foundations more eastward. If there was formerly a temple to Diana, he supposed it might have been within the walls of the colony, and more to the south. It was no little perplexity to fall in this at last; he wanted but six or seven feet to compleat the design, and this fell in the very angle north-east; he knew very well that under the layer of pot-earth there was no other good ground to be found till he came to the low-water mark of the Thames, at least forty feet lower. His artificers proposed to him to pile, which he refused; for though piles may last for ever when always in water (otherwise London Bridge would fall), yet if they are driven through dry sand, though sometimes moist, they will rot: his endeavours were to build for eternity. He therefore sunk a pit of eighteen feet square, wharfing up the sand with timber, till he came, forty feet lower, into water and sea-shells, where there was a firm sea-beach, which confirmed what was before asserted, that the sea had been, in ages past, where now Paul's is. He bored through this beach till he came to the original clay; being then satisfied, he began from the beach a square pier of solid good masonry, ten feet square, till he came within fifteen feet of the present ground, then he turned a short arch underground to the former foundation, which was broken off by the untoward accident of the pit. Thus the north-east coin of the quire stands very firm, and no doubt will stand."—(From 'Parentalia; or, Memoirs of the Family of the Wrens,' pp. 285, 286. By Christopher Wren, son of Sir Christopher Wren, late Surveyor-General of Royal Buildings. London: 1750.)

MISCELLANEOUS NOTICES.

The 'Dublin Quarterly Journal of Science' for April (No. 10) contains papers "On the Granite Rocks of Donegal, and the Minerals associated therewith;" and "On the Mineral Localities of Donegal, as ascertained by Sir Charles Giesecke and by the British Association Committee, 1861–2,"by Mr. Robert H. Scott; "Sketch of the Geology of the District of Shorapoor, or Soorpoor, in the Dekhan," by Captain Meadows Taylor, with three plates; "On the Geology of Parts of Sligo, etc.," by Mr. H. B. Wynne, F.G.S., with a plate and a list of fossils collected; "A Sketch of the Geological Structure of Finland, by H. J. Holmberg, of Helsingfors. The other geological papers which have appeared during the present year in the former number of this excellent journal, are, "Notes on the Geology of the East Coast of China," by Thomas W. Kingmill; "The Dhurmsalia Aerolith," by the Deputy Commissioner; "Note on the way in which the Calamine occurs at Silvermines, Co. Tipperary," by Mr. J. Beete Jukes.

The May number of 'Silliman's Journal' contains with, as usual, other highly valuable articles, papers "On American Devonian," and "On the Flora of the Devonian Period in North-Eastern America," by Dr. J. W. Dawson; On the Glacial Origin of certain Lakes in Switzerland, the Black Forest, Great Britain, Sweden, North America, and elsewhere," by Professor A. C. Ramsay, F.R.S.; "On some Questions concerning the Coal-formation of North America," by Mr. Leo. Lesquereux, being "Concluding Remarks on the Fossil Ferns," and remarks on "Calamitariæ;" and "Observations upon some of the Brachiopoda with reference to the genera Cryptonella, Centronella, Meristella, and Allied Forms," by Professor James Hall.

REVIEWS.

Natural Phenomena, the Genetic Record, and the Sciences, Harmonically Arranged and Compared. By Alexander M'Donald. London: Longman and Co. Sheffield: J. Pearce. 1863.

It would undoubtedly pass the ability of most critics to give a righteous verdict on this little book. We are by no means sure we should succeed in the task if we tried. It is the hardest reading we ever had; we will not say it is the driest. Its objects are evident.

> "The thoughtful mind," the author begins in his Preface, "when pausing to consider why so many members of the Christian community should be so excited whenever Biblical statements are tested, is apt to assign various reasons as the cause. One is the fear of beholding a brother weaker in faith led astray; another is the secret urgings of vanity, causing fools to decide upon what they have not toiled nor striven to acquire; and last, though not least, is that wavering uncertainty to which the human mind is so liable during this our preparatory stage.
>
> "We have reason given us, and allowed its use consonant to the range of our abilities. It is, therefore, the duty of each person to inquire concerning the truth of the Bible, although it may be beyond the reach of his mental power to conclusively grasp the whole."

So too the book opens very well—"Infinite and inexhaustible as nature appears to the investigator, the idea is continuously recurring that the laws which regulate the forces abounding thoughout the universe, are capable of being reduced within an extremely limited compass, and recognized as effects evolved from a few simple decrees, the ideal offspring of a superior intelligence." Even in the first sectional paragraph, however, the author shows his tendency to break off into that overweening word-picked style which puts the mind on a continual rack to comprehend his meaning, and will cause a painful feeling of labour and fatigue in ordinary readers.

> "Similar," he continues, "to the notes which regulate our musical combinations, so do the nature forces appear to the imagination of the truthful inquirer, who desires and seeks a cause for the various modes of cohesion, interfusion, and repulsion. As thought dates backwards and endeavours to simplify its ideas it seems extremely probable that like the first simple arrangement of our musical notation, so are the prime cosmical actions capable of being arranged. A few points are taken where power becomes force, and motal progression is generated and evolved."

This, however, is very mild compared with the following, which occurs at page 123, and is only a fair sample of what meets the eye wherever we open the book:—

> "Contemplatively pausing awhile, and reducing all sensuous perceptions within the limits of rest and motion, and viewing these under the terms electricity and magnetism, the bounds of knowledge may be still more tersely and clearly defined. Assuming electricity to be rest, rest as unitedly one is imperceptible, and is therefore a something apart from the perceptive electricity of science, which depends upon differential actions within this same vivic fluid or electricity; because to induce an electrically perceptive state there must be an opposition equal in power but different in balanced gradation to that which a certain subject has assumed," etc.

Or we may take the description of an atom at page 180:—

> "The atom, then, is individually a rigid atomic tetraedron capable of quadrate conic balance, so as to remain and continue stationary within the gravitating action of a sphere. Likewise, that although rigid radiation is the rule of its form, it can be divided into three distinct classes, for which the terms radiate, ovate and cordate are appropriate; the heading of these classes being oxygen, nitrogen, and hydrogen. These again disclose to us the how and why of chemical and mechanical assumption, and the theoretical principles of colour, sound, and heat; colour as radiant force, sound as voluminous distinction, and heat as spiral inclination."

Quaint, dogmatic, and semi-unintelligible as Mr. M'Donald's work is, we by no means condemn it, but we sincerely wish he had put his views clearer for the uninitiated, to whom his arguments must be incomprehensible. The following general summary, or rather selection of passages, will give the principal points of his views. We cannot undertake to translate into vernacular English even these, but this selection will enable our readers to judge whether they will be inclined to undertake the study, it cannot be merely the reading, of Mr. M'Donald's lucubrations:—

> "Taking the two kinds of existence to which all the components of the universe can be referred, there is evolved space—or, as it is ordinarily termed, vacuity—and solidity, or a something which ever retains the continuous impress of distinct characteristic individuality, endowed with formal repulsiveness.
>
> "As regards space, void and vivic, it seems that it is and must be a creation, because the genetic record tells of the creation of the heaven and the earth in the beginning; and if a creation, it of necessity exerts a more potent influence than the mere individual atomic solid, because its subtension is various and consonant to the mode and manner of its outline, being thus the working principle of the universe, the atom is the thing or material worked upon; accordingly as is the outline of a space varied, so is the internal influence. The outline may be varied, but a space created cannot be annulled. It may

be divided, re-united, caused to become monocentral or spherical, bicentral or elliptical, or polycentral, having varieties of outline; but the abnegation of its being, as an abidance and voluminous property, involves a *reductio ad absurdum* termination. A space appears as if you can do anything with it but nullify its existence; an atom, as if you can only combine or separate its units,—an individual existence without variety." . . . . "The Genetic record also implies the existence of life before light as in the commencement or in the beginning, before the exertion of such,—thought and capability before the exhibition of geometric realities—the existence of the Creator before the creature. From the first institution of antagonistic influence or force, although the indications of formative abidance would be various, the rule in the long run would be subdominant to requirements depending upon the numerical ratio of the prime forces, whether one, two, three, four, five or six, and to the intermutual balance of these powers, and the static ability of their forces. Although the prime powers evolved would be the distinguishing exterior characteristics of this era, yet the internal exhibition of antagonistic force confliction would develope inferior, medial, and superior organisms according to the ratios, multiplying in intensity of contradiction and confluence.

"The sixth day being also an animal life era, it becomes consonant to the purpose of our theme to speak of them and treat them as one, only with this difference, the fifth era opens unto us all appertaining to curvilinear, circular, and hemispherical purchase becoming ovoid combination and pointed repulsion, or the advancement of life into death. The sixth era, on the other hand, opens and explains the limit of death and the retrocession of death unto life eternal. The wording of the sixth day is:—'And God said, Let the earth bring forth the living creature after his kind, cattle, and creeping thing, and beast of the earth after his kind. And God made the beast of the earth after his kind, and cattle after their kind, and everything that creepeth upon the earth after his kind: and God saw that it was good.'

"The main distinction between the fifth and sixth day is, that water is the vehiculous medium of the fifth; earth of the sixth. The fifth day tells the story of wave or undulant cohesive advancement with a tendency towards rest and parallel plane decadence. The sixth as the beginning of arrest and retrocession, that of continuous regular gradation and comprehension. It encloses all that has been done prior to its institution, balances it, and struggles to lead it back—condense, and confine the volumes of space within an harmonic boundary, and balance such upon an equidistant centre. As the former eras were but the lustrous eviction of a life evading and relapsing into rigidity or death, so this is the toned regular balance of progressional static requirements, leading unto an eternal state of enduring stability, its oneness of volume harmonized throughout its entirety. If the times of the six points had been simultaneously taken and originated, the numerical relations of the internal harmony would have been equal, similar, and equibalanced; therefore an octaedron of regular tension would only have been attained. The Genetic record, however, tells us, and nature bears testimony to the fact, that time elapsed between the institution of each of the six points, therefore we understand how that although all must continually tend towards the true geometric centre of the universe, such point is not the electric status of never ending rigidity, but the focal realization of eternal abidance, a referential gradation of harmonic rest and stability. This likewise discloses the appropriateness of the idea of God resting upon the seventh, because the seventh point being once attained, and such point centrifugally varied, the inevitable conclusion is the exterior exhibition of eight balanced points as cubic comprehension, when the six points of prime institution become as it were extinguished and null or centre of each square, and become again balanced and developed at the points of each square. When the last trumpet is sounded, and the new heaven and the new earth become perceptible, then will eternal perfection have been attained, and the eighth or everlasting era be inducted. Centrifugal and centripetal force will then have been truly harmonized, and solidity, vacuity, and space influence concordantly appropriated. It may be that those who are possessed of, and have cultivated their superior intellects, may be enabled to travel through the universe under the guiding protection of the Deity, if their intellects are attuned consonant to His will; whilst the inferior and non-consonant intellects must have more restricted range. The inferior intellects, happy in their restricted sphere, the non-consonant superior intellects, cropt of indulgences, their state, therefore, what!—will it be that of an unsatisfied, envious yearning, or a pruning and reduction of unsightly excrescences until they sink into some inferior position, low—low in the scale to what they might have occupied.

"Leaving this intensely metaphysical subject, we can perceive how the point of the seventh being once attained, true and eternal sphere motion would be gradually originated, increasing and increasing until the limits of the six prime stations are reached. The eternal sphere or globe would then have attained its utmost limits, and influential force would then expend its remaining impulses in the formation of a cubic outline, exterior to the sphere, with the six prime powers centre of each square. The problem of the New Jerusalem, mentioned in Revelations, has bearing upon this point, because it is there stated that the city lieth four-square, and the length is as large as the breadth; and also that the length and the breadth and the height of it are equal.

"The millennial era, or the binding of Satan, is likewise of peculiar importance here, because the first resurrection is perhaps noiseless and gradual, the second instantaneous and reverberatory; as if it were the sudden resolution of all dissonant materialisms, and their forcible banishment either to centre or circumference, the abode of the truly blessed being medial between the two extremes." . . .

"If we look upon the creation of Adam as a mechanism endowed with faculties resembling those of his Creator, then it seems we must accord to man three powers, those powers being capable of varying in all grades, but never capable the one of totally comprehending the other, of separating itself therefrom, or of maintaining a separate position apart, to the total exclusion of the other two. Ever three, and yet one; ever capable of variable extension or contraction, and yet mono-central as regards the combined unity.

"Adam, being created, could not be totally self-reliant, of necessity he must be dependent upon the care of his Divine Creator. The life-volume of Adam's existence not being self-eternal, or not self-existent, at least one plane or point of such volume must be everly stationary or reliant.

"If one supremely selfish attempt were made to live alone and independent, the Adamic creation having a beginning, seems to give the result thus: A living death or a resolution of the Adamic life or beauty into simple atomic elementary existence, because the power becoming totally mono-central, would return unto the key-note of its first production, become electrically repulsive, and subsiding into silence end the life harmony of man upon earth. The effects of eating of the tree of life, would, according to this view, have been a centration of the life vivifying forces so as to cause eternal intellectual death, or constriction of the life components, giving, therefore, life eternal as a simple exercise of station—a mere atom. On the other hand, the effects of eating of the fruit of the tree of the knowledge of good and evil, implies an inquiring mind, a desire to know without the self-assumption of supreme arrogant presumption, a species of timidity mixed with the sin. As the tree of life gives only one point or radiant instantaneous death, the tree of the knowledge of good and evil gives two points, or an undulant tendency, causing the three to become five, and therefore requiring time till the power vacillating, extending, and fluctuating, gradually subsided into death or various grades of simple outline existence. This human life decadence we know and believe to have been arrested by 'Jesus' perfectly accomplishing an appropriate work at, and during the appointed time." . . .

"Imperfections and mis-statements may be found here and there in the Bible, because as a book it is subject to the variable free will force of man. Be that as it may, if from such a book we can glean sufficient to enable us to know the how and why of creation, and of the appearance and glorious work of Jesus, it is all that is absolutely necessary for the purposes of salvation.

"As a still more condensed view may be agreeable to the purely scientific, the following is given:—

"There are three species of space occupation, and these are the vivic or fluid occupation of space, the void, and the atomic, or the rigid unchangeable delineation of a space.

"There are three varieties of space harmony;—the magnetic, thermic, and electric. The magnetic relates to motions within a fluid or connected volume. The electric relates to the actions of distinct and separated volumes. The thermic to the compound amassment of distinct volumes and interspersed fluidities."

We have given in these selections a fair sample of the work; every individual who reads it must judge of its value for himself.

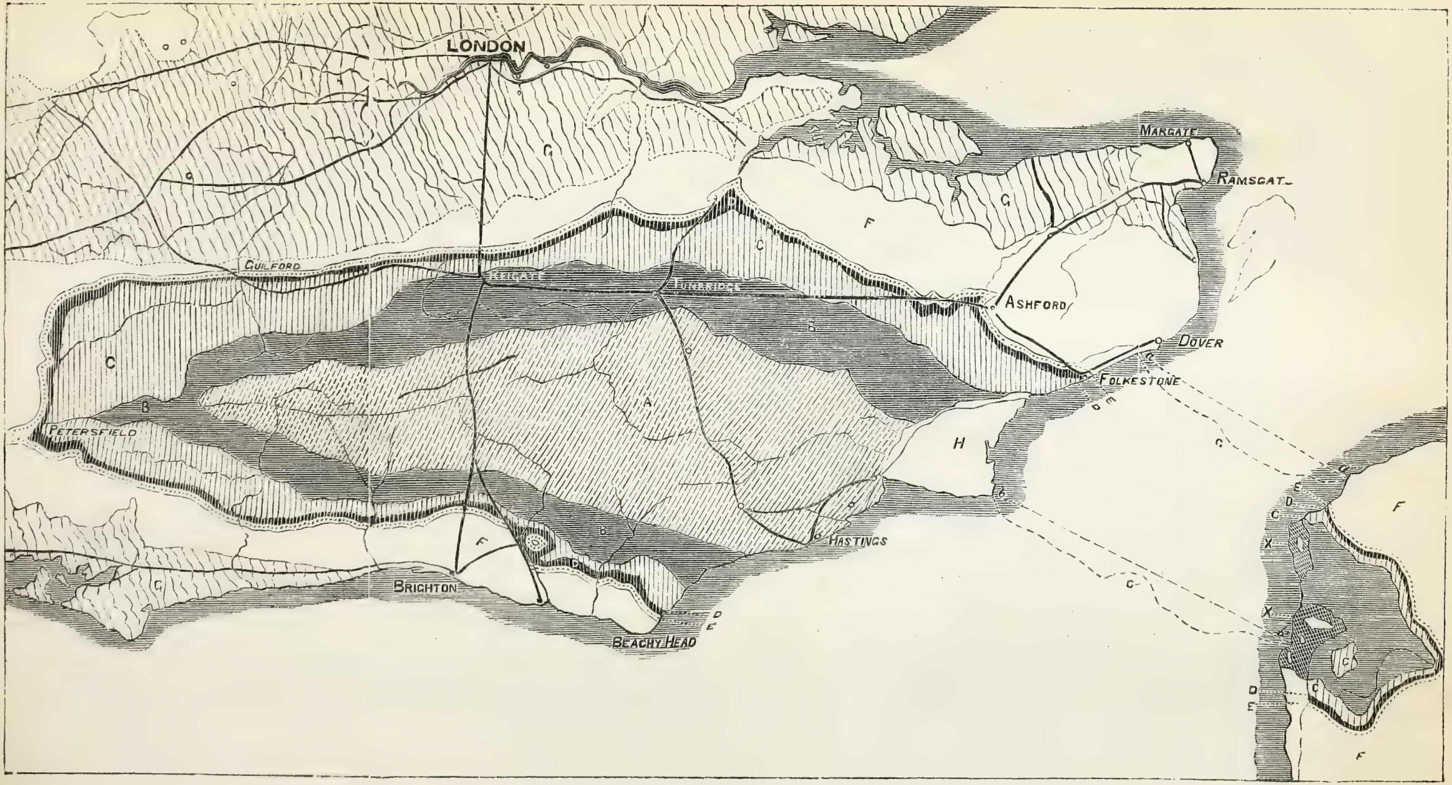
Introductory Text-book of Physical Geography. By David Page, F.R.S.E., F.G.S. London and Edinburgh: Blackwood and Sons. 1863.

What can we say more of Mr. Page's book than that it is the best of its kind? We have said the same of his geological text-books before; and we repeat the praise for this. Mr. Page's books, however, deserve more positive praise even than this, for in themselves they are excellent treatises, characterized by great painstaking in getting good information, and judgment and ability in using it when got; while his originality of thought always carries his works far beyond the class of compilations. This text-book of physical geography, like the author's 'Introductory Text-book of Geology,' conveys in a simple, sytematic manner, the leading facts of the science to which it relates; and the learner is not troubled with masses of details which it is impossible for him to remember, nor is he debarred from study by an array of subsidiary topics and data altogether unneeded in the first elementary comprehension of a science. The contents are physical geography, as a science; the general condition and planetary relations of the earth;—its individual structure and composition; distribution of land and water; the superficial configuration of the land—its highlands, its lowlands; the water—its rivers and lakes; climatology; the atmosphere; the distribution of plants and animals; ethnology—races and varieties of man: and a general review, with deduction of the whole mass of subjects. We need scarcely add, Mr. Page's book has our good wishes and most hearty recommendations.

The Geology of Leek. By Thomas Wardle, F.G.S.

Leek, in Staffordshire, stands chiefly on the Triassic rocks. The Carboniferous rocks also appear, and Post-Tertiary deposits are met with in the district. The subdivisions of the rocks, their principal localities and ranges, are well and orderly described; as are also the physical aspects of the region, its rivers, brooks, and springs. At the end of the work are model lists of strata, with the characteristic fossils bracketed to each, and a note of the locality in which each occurs. There are also classified lists of fossils, and four very well lithographed plates of figures. The book is very nicely printed, on very good paper, and bound in cloth. In every way it deserves to rank with the best local books in our literature, and is one of a class that we should like to see more frequently produced.

PLATE XVI.



MAP OF WEALDEN AREA OF SURREY, KENT, SUSSEX, AND THE BOULONAIS.

S. J. Mackie del.

THE GEOLOGIST.

AUGUST 1863.

THOUGHTS ON DOVER CLIFFS.

By the Editor.

On the shore of the English Channel, half hidden by its shady grove of trees, stands Walmer Castle, the sweet red roses trailing up the ramparts and clustering in lovely bouquets round its cannon, emblematic of the peaceful end of him—illustrious Wellington—whose last breath ceased within those grey stone walls.

From this lonely beach, against whose front the "wild waves ceaseless play," creating their own barrier in the great banks of shingle which ceaselessly they raise, we look out upon the fleet of vessels in the Downs, and far beyond the long white line of surf—the shroud of many a noble heart—that marks the Goodwin Sands, is seen the distant coast of France.

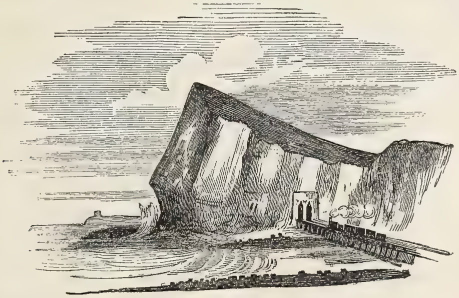


Fig. 1. Shakespeare's Cliff, Dover.

From Walmer, the "white cliffs of Albion," so conspicuous here for their numerous and regular bands of flints, gradually rise towards Dover, whose far-famed castle stands on a mountain mass of microscopic shells, overlooking the red-roofed tenements of that ancient port, winding along the deep valley which at this point cuts abruptly through the strata.

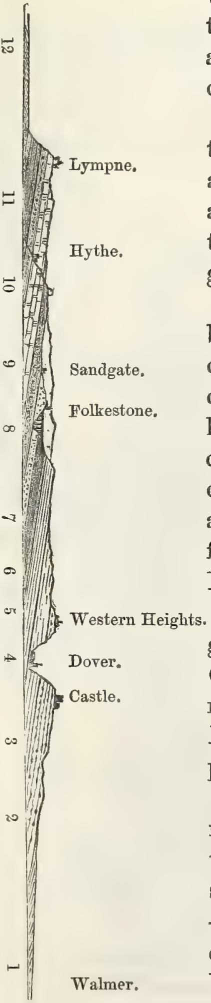


Fig. 2.—Section of the Cliffs from Walmer past Dover to Lympne.

1. Rubble. 2. Upper White Chalk, with flints. 3. Middle White Chalk. 4. Grey Chalk. 5. Upper Greensand. 6. Gault. 7. Folkestone Greensand. 8. Sandgate Greensand. 9. Kentish Rag. 10. Neocomian Sand. 11. Weald Clay. 12. Alluvial (Romney Marsh).

The opposite hill is furrowed in its entire extent with the trenches of the citadel, and at the foot of its steep cliff is the long and narrow street which formerly, when the town was walled, led to the Snaregate.

On the western side of the harbour the bold front of Shakespeare's Cliff forms the commencement of a splendid range of cliffs, which rise to a height of nearly six hundred feet, the fallen masses of which constitute a picturesque and romantic undercliff, carpeted by a short crisp herbage, and abounding in beautiful plants that furnish subsistence to many of the rarest British insects.

On the shore, a narrow seam of dark greensand represents the "firestone" of Godstone and Reigate; and gradually rising from the flat strand of Eastwear Bay, the blue gault forms the ruinous promontory of Copt Point.

The sandstone cliffs at Folkestone—more rugged and still more picturesque, though less singular in character than the sheer white masses we have just passed by—are covered by white marl and ochreous gravel, containing hundreds of the bones of extinct mammals, mammoths and hippopotami, savage hyænas and gigantic deer and oxen; while above and beside them are buried the rude urns, rusted weapons, and mortal relics of our Saxon ancestors.

As we skirt the brow of this high ground, from amidst the yellow-greenish sands below, layers of rough rock jut out, and dark furze and scraggy bushes luxuriate in the softer intermediate soils.

Descending to the lower level of the pretty village of Sandgate, ferruginous springs and equisetaceous plants mark the spongy pyritous "Middle" Greensand; and as we trace along the verdant slopes from Hythe to Lympne, the grey hard "Kentish rag" on which they rest, crops out, and we step over hundreds of sparkling rills of limpid water with forests of crisp watercress.

How solemn in their teachings become the mouldering bones in the vaulted crypt of the old handsome church at Hythe, after an inspection of the tiny Cypridæ in the Weald Clay on which they rest; and weather-beaten Studfall, with legends older than those of its Roman days written in its massive lichen-stained walls, speaks to us more touchingly of the vicissitude "of all things human," when we reflect on the landslips that have overturned its massive towers, built and guarded in its ancient days of glory by the invincible legions of the "Empress of the World,"—the "Eternal City," now fallen and prostrate as these crumbling ruins.

Every inch of the ground is fraught with historical associations and local incidents, and every fragment is filled with natural wonders which carry the mind beyond the ages of history into the boundless and interminable past, heightening the enjoyment of the picturesque scenery around, and mingling with the very essence of our souls, admiration, love, and gratitude to that great Being whose attribute is eternity, and whose kingdom is illimitable space.

How enlarged and ennobled our ideas of his inestimable supremacy become as we trace through the records of the great geologic ages, the gradual unfolding and slow and solemn workings out and development of his far-foreseeing plans, and find no traces of discord, chance, or chaotic confusion, but see in the earliest times the radiance of his glory, and in his, to us, most primitive creations the same vivid impressions of his power and wisdom as in the most recent and most elaborate of his works.

There is perhaps no isolated portion of geology that has more clearly proved the immensity of geologic ages, than the group of rocks we are considering. As at the present hour the sea is washing away cliffs and shores, and dispersing the material,—

"Ever drifting, drifting, drifting,
On the shifting
Currents of the restless main;

Till in sheltered coves and reaches
Of sandy beaches
All have found repose again,"—

so in former ages, the finer particles of earth derived from the waste of the land were carried by the currents of the ocean miles and miles away, and, deposited in its tranquil depths, have formed those important argillaceous, calcareous, and sandy strata of which the external crust of our globe is mainly composed.

Such operations and the accumulation of organic débris, chiefly of a microscopic character, effected the deposition, and volcanic or some other equally powerful internal force, the elevation of those great masses of stone, sand, and clay, which are grouped by geologists together as the Cretaceous formation.

The fossil shells, fishes, echini, and sponges of the Chalk and its associated beds, clearly prove their marine origin; while the remains of sharks, nautili, ammonites, and other forms of animal life usually predominant in warm latitudes, are, without going into more minute details, sufficient to indicate the warmer temperature and different climatal conditions of our geographical region during the Cretaceous era.

Of the many records of the past, nothing is useless; no portion without its value. The embedded shells give us important evidence of the rate of the accumulating sediments, and record their progress. In the beds we are studying, especially in regard to the Chalk, they teach us how slow and gradual was the deposit of sediment; for the encrusting parasites on fossil bones and shells, betoken how long these dead objects lay in the ocean-depths ere they were finally entombed in their massive grave.

How slowly and solemnly did the mighty work proceed; how vast the period over which it extended. Each of all the myriads of those departed beings whose remains teach us the history of their age, must have had its term of existence, have lived and died, as do the creatures of the present, ere the growing cemetery enclosed it in its "cold embrace."

"When we see," says Lyell, "thousands of full-grown shells dispersed throughout a long series of strata, we cannot doubt that time was required for the successive multiplication of successive generations;" nor when we see the internal parts of fossil oysters and other shells covered with Bryozoans, Serpulæ, and other encrusting bodies, can we doubt their having lain at the bottom of the sea after death, while these parasites lived, grew, and died before they were embedded in the slowly accumulating mud.

In my former collection, now the property of the town of Folkestone, there is a fossil oyster—by no means an uncommon example—having a second oyster attached to the inside of one valve. This specimen could neither have been suddenly enveloped nor even embedded shortly after death. Decomposition and entire disappearance of the animal must have taken place before the smaller oyster could have fixed its residence. This too must have died, and the connecting ligament of its valves have decayed, before the detached valve was worked away, and both oysters, old and young, embedded together.

Of all the numerous specimens of the prickly sea-urchin tribe from the Cretaceous rocks, to find one with any of the spines attached is rare, while the test itself is often coated with Serpulæ and other parasitic forms. In such cases also, not only death and the subsequent decomposition of the muscular integument must have happened, but the spine-divested body-shells of the Echinoderms must have remained exposed on the sea-bottom, while these extraneous beings lived out the full periods of their existences.

The extremely slow formation of the Chalk is further displayed in its microscopic structure.

Amongst all the wonders which geology has revealed, there is nothing perhaps more wonderful than that the very substance of solid rocks should be composed of the remains of the minutest animalcules. Yet such the microscope has shown; and chalk is one of the numerous instances.

Every atom, each individual particle, was once part of a living creature. Thousands of miles of solid rock, hundreds of feet in thickness, form thus a mighty tumulus of fragile invisible beings,—the cemetery of the unseen; beings not suddenly nor violently destroyed, but that naturally sported away their lives above the dead ones of their race, a million of whose carcases scarcely formed a cubic inch of the Cretaceous ocean's mud.

Beautifully and truly has it been said, that "the majesty of God appeareth not less in small things than in great, and as it exceedeth human sense in the immensity of the Universe, so doth it also in the smallness of the parts thereof." The deposits of the Cretaceous period are very extensive, and are found in Belgium, Holland, Prussia, and over the greatest portion of Europe. A map of the divisional boundaries of the ancient lands and seas of that remote geological age would display very different dispositions of continents, islands, oceans, than now exist. All through the great Tertiary ages, the Pleistocene and the historic periods, the sea has been at its ancient toil, destroying and renovating, pulling down and levelling. All through those vast periods the winds and rain, and frosts and snows have been abrading and disintegrating the mountain-rocks, and slowly bringing down the detritus to the river-valleys and the sea. All through those vast ages—reckonable only by millions of years—the earthquake and the volcano, subterranean expansions and contractions have contested with the air and the water the dominion of the earth, and have maintained the supremacy of the dry land over the storm-crested "waste of waters."

We have been over some twenty miles of ground in our brief and rapid notice of the Cliff-section of the Kentish coast; we have gone ages back in our reflections; we have spoken of the rocks which form those cliffs as having been the mud beneath or the sands upon the shores of an ancient ocean long since passed away. Let us sit down now under the shade of the massive walls of the Roman *castrum* where first we halted in our mental ramble, and shortly tell the history of these lofty cliffs, "white, blue, and grey," yellow and green.

Fine calcareous matter, stiff mud, siliceous sands, all the produce of the salt sea, all once deposited in the depths or on the shores of ocean, now two, three, four, and five hundred feet above the waves. All once piled nearly flatly over each other like so many books on a table, now tilted up edgewise like volumes in an open space on a library shelf. If, reader, you are a geologist, you will know something of what I am going to tell, for the Wealden district of which our section forms a part is too remarkable not to be well known to scientific men. If you are not a geologist, then, though I tell an old tale, it will be one that will mightily interest you if I tell it well.

There was—how many ages since no one can say, no figures express; but it was long, long ago, if even we could reckon by ages—an ancient continent spreading over all this region round, not then so temperate as now, but hotter and more like the tropic band; on its shores tall trees and a rank luxuriant herbage grew. Gradually the forest-covered soil sank down, and gradually the great river that drained the continental tract spread wider and wider its mud and ooze. There in its swamps gigantic lizards and winged reptiles sought their food, and there oft during the æstival droughts millions of marsh-mollusks on the half-dried banks retreating into their spiral homes were baked by the hot sun into beds of beautiful marble (Bethersden and Purbeck), so often since polished into pillars for holy places, or chiselled into seats for saints.

In the lapse of further ages—for Time's march has never stayed—the salt waves curled and broke in writhing foam, and the sea-breezes rippled the ebbing tide over the shallow sands, which the rain spattered and the creeping things of the shore streaked and dotted with their footprints.

Down further yet went the ancient land, and the mud took the place of the sand; further still and the fine calcareous ooze of a deeper ocean succeeded to the mud; and the river-mussel and the reptile were supplanted by the ammonite and the shark; the trees and insects by the mollusk and foraminifer.

The ancient trees of that old continental land are still dug up in the Purbeck beds; the bones and teeth of the Iguanodon, the Pterodactyle, and other gigantic reptilia are often exhumed from the sands and clays of the Wealds of Kent, Surrey, and Sussex; and the ripple-marked sandstone is daily quarried at Horsham, Hastings, and Rye. Ammonite and shark, crab and shell-fish have left their solid cases, bones, and teeth in the ragstone, greensand, and gault, and even traces of the soft flesh of the latter yet remain as brown nodules of molluskite in some of the sandy beds of stone.

Further still sank the ancient land with its overpiled sediments until the faint currents of the ocean-deeps scarcely stirred the tiny valves and weightless shells of microscopic entomostracs and foraminifers,* powdering the fine calcareous mud in depths which the light of heaven only dimly reached.

All these various beds, formed during the vast period of those strange changes, however dissimilar in their present state they may at the first glance appear, both in mineral composition and in the physical conditions of their deposit, are nevertheless found to be naturally associated, when the sequence of their succession and the nature and value of their organic remains are known.

No general distinguishing mineral characters can be universally assigned to these various divisions, for the composition of the beds of every age varies with their geographical extension, and according to the ancient conditions of that part of the Cretaceous sea on which they were deposited. Thus in places far removed from Kent the argillaceous gault of England may be represented by a hard rock or an incoherent sand; or the fossils of the Upper Cretaceous beds may be enclosed in strata totally unlike the soft white chalk of England; the upper beds of which, too, in some parts of Europe are devoid of those bands of black flints which so conspicuously characterize our own: while on the other hand the Lower Chalk which is here without them, elsewhere on the Continent encloses numerous bands of siliceous concretions. The grey chalk also in some places abroad contains white-coated flints and beds of chert, and may be represented by a limestone in one geographical district, and by a sand or a clay in another.

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* Some portions only sank to this great depth. The area of Kent and Sussex was nearer the old continent, and consequently sank into less profound though still deep water.

The various divisions of the Cretaceous formation in the limited area this book describes are, however, marked by real discordances, both petrological and palæontological, while some connecting organic forms link the whole into one proper geological group, containing upwards of 5000 characteristic species of fossils distinct from those of the Oolitic strata below, and from those of the Tertiary beds above.

But to return to our history, from which we have thus somewhat digressed. All these strata, which we have so far traced as sea-deposits, have been raised from their nearly level position and tilted with slightly upturned edges. In our section (fig. 1) they dip 7° to the east-north-east. In Sussex the like beds dip the opposite way, and they vary all round the semicircle of the Downs, assuming a more and more northerly dip as they approach from either hand its central portion in Surrey; pointing indeed away in all directions from a common centre near Battel, in Sussex, as may be seen in the map, Pl. XVI.

At intervals these chalk downs are broken by transverse gorges or river-valleys, while the great interior area of the Weald presents the lowermost, or, as from this circumstance they are termed, the Wealden strata at the surface entirely divested of those cretaceous sandstones, clays, and chalks, which in the Kentish cliff-section are seen to repose upon them.

Now either those chalk-strata and greensand were never deposited over this area, which their thickness at their truncated edges, as well as the steepness and height of the surrounding escarpment of the

Downs forbid us to suppose, or they have been swept off from it since.

To this latter conclusion we must inevitably come; but then the question arises whether the Cretaceous and Upper Wealden beds extended over this area in their full thickness; if so, from off this region the rocks must have been swept away to the extent in vertical height of more than 1400 feet.

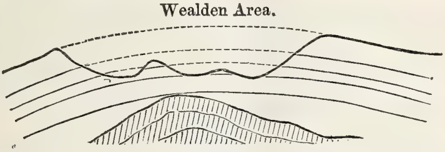

Fig. 3.—Dome-shaped strata over the Weald, of equal thickness throughout.

Some geologists, however, and with good reason, consider that the beds became thinner as they overlapped the Wealden district; and it is certain a great submarine ridge has existed at this spot from the Carboniferous era, if not from an even earlier date. The sea might therefore naturally be supposed to have shoaled over this tract, and consequently the deposit would not have been so thick as in the deeper parts of the sea.

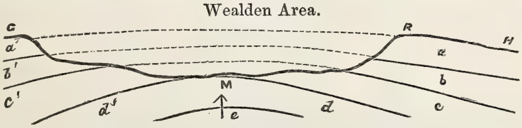

Fig. 4.—Strata diminishing in thickness over the central or Wealden area. *a*, Upper Chalk; *b*, Lower Chalk; *c*, Gault and Lower Greensand; *d*, Weald clay or Old Wealden land.

The proof of this surmise would be in the diminished collective thickness of the groups of strata (as between *h* and *g*), as one after another abutted against the submerged slopes of the ridge and was

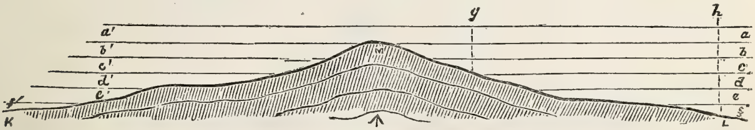

Fig. 5.—Ideal section of strata abutting against a ridge. *a*, Upper Chalk; *b*, Lower Chalk; *c*, Gault and Lower Greensand; *d*, Neocomian beds; *c*, Old Wealden land.

terminated; or in the difference of diminished dip of the superior over the inferior strata.

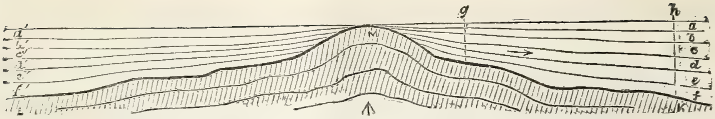

Fig. 6.—Ideal section of strata thinning out against a ridge.
a, Upper Chalk; *b*, Lower Chalk; *c*, Upper Greensand; *d*, Gault; *e*, Lower Greensand; *f*, Neocomian beds; *g*, Old Wealden land.

We have already pointed out the convergence of the lines of dip towards a point near Battel. There was the apex of the great dome, the outer concentric coatings of which, whatever their original thickness, have since been sliced off—denuded by cutting action of the waves as the island-dome was slowly elevated out of the waters.

Now the physical features of this region, as we at present see them after its upheaval, show that the area uplifted was the area of weakest resistance to the upheaving or expansive forces below, and that that area had a configuration not unlike that it still retains, although it would appear that the denudation of the upper beds was carried on synchronously with the gradual upheaval of the mass throughout, *at least* throughout the early Tertiary period, and since the fracture of the river-valleys, *at least* over the area enclosed by the downs, from which the débris of the shattered beds has been cleanly removed. (See Fig. 12.)

As certain as the laws of mathematics are the laws of such elevations. The hills, irregular as they appear to be, are not vagaries of nature, nor are the valleys fortuitous cavities. The Wealden area is an irregular curved oval, cut through by the fissure of the English Channel; the counterpart encompassing the neighbourhood of Calais and Boulogne.

If one applied a pressure from beneath to a deal table, a tile, or any other square or straight-sided object, it would split linearly across in one direction or the other, as in Fig. 7 or Fig. 8. If one applied the pressure against the under surface of a drum-head, the parchment would split either in concentric lines, as in Fig. 9, around, or in radiating lines, Fig. 10, from the centre. Now, an oval is practically a compound of the square or parallelogram and the circle, as shown in Fig. 11; and the consequence of the upheaval of a dis-

Fig. 7.

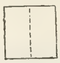
Fig. 8.

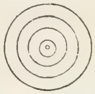
Fig. 9.

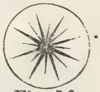
Fig. 10.

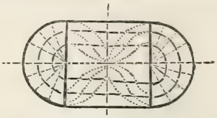
Fig. 11.

trict possessing a contorted oval shape by an equally-pressing power from below, such as an expanding volume of gas or steam, or the expansion of a heated rock-mass, would be to fracture the superincumbent rigid beds in lines partly concentric, partly straight, partly radiating and partly curved, according to their position with respect to the centre or sides of the region upraised.

Such are really the characters of the lines of the hills and valleys of the Weald and the Chalk gorges. The comparatively straight line of the St. Leonard's and Ashdown hills passes by Horsham, Crowborough, and Wadhurst; the concentric ridges by Lewes and Dorking, while the diverging radiating lines are the great cross-fractures through which the rivers of Kent, Surrey, and Sussex find their outlets to the sea. (See Map, Pl. XVI.)

To return again to our history. Since the sediments of the Cretaceous ocean were consolidated into rock, they have been furrowed by another ocean as they rose into land, and other newer deposits formed of their débris. Of such origin are the Thanet sands and the plastic clays of Reading and the Isle of Wight. These and many other of the Tertiary beds of the surrounding country are nearly wholly formed of the greensand, clay, chalk, and flints of the wasted Wealden land, and have been accumulated on its ancient successive shores.

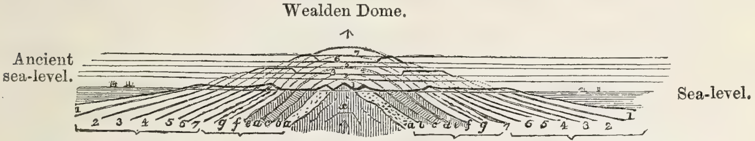

Fig. 12.—Section of the present strata across Kent and Sussex, showing the successive ancient sea-levels at which the former Wealden dome was periodically cut away as it rose above the sea: the Upper Chalk, 1, being first cut away; then the Middle Chalk, 2; then the Grey Chalk, 3; then the Upper Greensand, 4; then the Gault, 5; and finally, the Lower Greensand, 6, and Neocomian, 7. These beds forming consecutively the corresponding Tertiary beds, No. 1 to 7; on the older secondary strata, *a* to *g*. These are *a*, *b*, Neocomian and Lower Greensand; *c*, Gault; *d*, Upper Greensand; *e*, Grey Chalk; *f*, Middle Chalk; *g*, Upper Chalk.

The Tertiary period passed away, and the age of the great mammoths succeeded. On our hills and plains, and in the alluvia of our river-valleys, are spread the bones of elephants, deer, hippopotami, and oxen that ranged across the narrow isthmus which then connected our land with France, and which still leaves traces of its former position in the ribbon of shallow water between Folkestone and Boulogne.

Interesting indeed are the inquiries—When was the Wealden dome first raised and how denuded? When were the British Isles disjointed from the continent of Europe? When were the white cliffs of England split apart from those of France?

A submerged or island dome, as we have already said, appears from all we know to have existed over the site of the present Weald at the close of the Coal Period; and from the indications we derive from deep borings in the surrounding regions, it would be inferred that the Triassic beds were certainly wanting, and that the Oolitic or Jurassic formation was also absent, the Wealden beds reposing, in all likelihood, directly on the coal-measures.

That this region in the early Cretaceous age was in close proximity to dry land is certain, from the fossil trees and the reptilian bones found in the Lower Greensand quarries at Maidstone, and inversely from the thinness of that division in the Boulonnais.

From these and many other circumstances, it would appear that England was not cut off from the great mass of land then stretching away to the westward by Cornwall and Devonshire on the one hand, and Brittany on the other, at the close of the Cretaceous era; while the evidence of the Pleistocene deposits proves that the fissuring open of the whole extent of the English Channel was either just prior to, or coincident with, those early tribes of the human race whose remains and rude stone weapons are found associated with the half-petrified bones of the gigantic beasts of that remarkable age.

But whenever this may be supposed to have happened, the same convulsions shook both countries alike, and the process which lifted up the Wealds of Kent and Sussex raised also the hills of Boulogne and Calais, and left them all portions of the same vast mound, until that other and later catastrophe fissured out the "narrow stream," on either side of which dwell those great and glorious nations of whom the poet wrote that they abhorred each other, but for whom science now has changed the deadly war of mortal strife into an honourable rivalry for supremacy in the arts of peace.

Strange thus that science should bring down the fracture of the Channel to the age of man! Have the old traditions of the Armoricans aught of relation to this great event,—the rupture of the British Channel? Have the tales of the loss of "forty miles of land and sea," so current in Brittany and Wales, been handed down from an antiquity far more remote than that to which they are usually assigned? Is there any probability of that submergence of the Léonnais that Norman troubadours sang of when they told the sad story of Guinevra's falseness to her noble lord, being concurrent with the isolation of the British Isles? We do not, of course, take for true history the highly-coloured scenes of a romaunt, nor believe in all the wonderful doings of King Arthur, Sir Tristram, Meliades, and the other heroes of the song-stories of the twelfth and thirteenth centuries; but we do know that many of these fable-songs were based on still more ancient legends, and may not these lays be but the embodiments in after ages of primitive traditions of far, far remote events?

Through Kent there is a narrow ancient way, now known as the Pilgrims' Road, for along it our first of poets, Chaucer, made his "merrie motley cavalcade" to wend its way to Canterbury. People, in less searching times than these, believed the road went on to Cornwall, and that along it Phœnician merchants brought their precious tin. Whether one end of this primitive way ever went towards Cornwall, or whether remnants of that one end may still be found at our British kingdom's end, this deponent saith not; but he does believe, —it may be but a childish fancy, for we like to deck our childhood's cherished grounds with strange romantic fancies,—that its other end does end upon the Folkestone heights, and that only now because it can go no further, but whence it might have crossed the "narrow sea" before the chalk cliffs there ended it so abruptly. Strange it is to think that primitive men and mammoths might have walked along that road. The grass springs up and withers away, and the silent earth telleth no man's history.

FORAMINIFERA OF THE CHALK.

By the Editor.

The Foraminifera figured in Plate XV. are some of them copied from D'Orbigny's 'Memoir on the Foraminifera of the Chalk near Paris,' and some are from drawings of Cretaceous specimens lent by a friend. The figures do not furnish anything like a perfect or consecutive series of these interesting Microzoa, though some of the most common forms are here depicted, and will well serve the purpose of drawing the attention of our correspondents and readers to the points of interest referred to at p. 234, No. 66.

Professor Rupert Jones, F.G.S., has obliged me with the following notes on the figured specimens:—

Plate XV., Fig. 1, 2. CRISTELLARIA ROTULATA, *Lamarck.*

A common form of *Cristellaria Calcar*, Linn., sp., having but little keel, and very variable in this feature, as well as in the curvature and elevation of the septal lines, the convexity of the umbones, and the shape of the aperture, which may be either round or triangular. It is exceedingly abundant both in the fossil and the recent state, the largest specimens are found in strata of late Tertiary age and in the existing seas; and under its various modifications it has received many different "specific" names. *C. rotu-*

lata is very abundant in the Gault, Upper Greensand, Chalk-marl, and Chalk. Its occurrence in the red chalk of Yorkshire is noticed in the 'Geologist,' 1859, p. 275; and 1860, p. 420.

Fig. 3. TEXTULARIA TROCHUS, *D'Orbigny.*

One of the most symmetrical of the Textulariæ,* and found chiefly in the Chalk, accompanied with *T. turris* and many other varieties.

Fig. 4, 5. TEXTULARIA AGGLUTINANS, *D'Orbigny*, var.

The Textulariæ are so variable in their growth, forming vesicular or flattened chambers, and arranging them sometimes so regularly and at other times with such a want of neatness, that there may be almost as many names for them as there are individuals. Fig. 4 and 5 are examples of this. Badly grown specimens of the typical form known as *T. agglutinans*, they form links with the variety named *T. fœda* and many others. These Textulariæ are extremely common in the Gault, Chalk-marl, and Chalk.

Fig. 6. TEXTULARIA BAUDOUINEANA, *D'Orbigny.*

This is another common form of Textularia, more symmetrical in outline and in the setting on of its compressed chambers, than Fig. 4 and 5. It can be scarcely, if at all, distinguished from a well-grown *T. sagittula,* Defrance.

Fig. 7, 8. PLANORBULINA AMMONOIDES, *Reuss*, sp.

Most of the Planorbulinæ, especially the larger forms, live in the shallower sea-zones, chiefly among seaweeds; but in deep water they pass into smaller and more compact varieties, such as Fig. 7 and 8. These subnautiloid forms are common in some of the Jurassic clays and in the Gault, Chalk-marl, and Chalk, and abound in the existing seas at depths greater than 100 fathoms.

Fig. 9–11. PULVINULINA† UMBILICATA, *D'Orbigny*, sp.

This belongs to a large family of Rotaline Foraminifera, which group themselves around *Pulvinulina repanda,* Fichtel and Moll., sp. It belongs more especially to the subgroup of which *P. Menardii* is the type. This attains its best growth at about 100 fathoms in the existing seas, but lives well at abyssal depths, even at more than two miles depth; whilst, on the contrary, in shallow water it degenerates into bizarre varieties. D'Orbigny's *Rotalia Micheliana* and *R. crassa,* figured on the same plate (Mém. Soc. Géol. France, iv. pl. 3) from which Fig. 9–11 have been copied, are also varieties of *Pulvinulina Menardii.* These are all three found in existing seas under the conditions mentioned above, and are abundant in the Gault, Chalk-marl, and Chalk.

Fig. 12. LITUOLA NAUTILOIDEA, *Lamarck.*

This is the elongate form of Lituola, the short condition of which is more or less nautiloid in shape. Lituola has very variable states of growth according to its place of living, and is often attached to shells, seaweeds, etc.; it has therefore many varieties, recent and fossil.

Fig. 13. MARGINULINA TRILOBATA, *D'Orbigny.*

Marginulinæ are Cristellariæ with short chambers, arranged without coiling, except at the commencement. They are present wherever Cristellariæ abound.

Fig. 14, 15. LINGULINA CARINATA, *D'Orbigny.*

This is a smooth compressed Nodosaria, the gradation from cylindrical to flattened forms being extremely gentle in numerous intermediate forms; and further, these flattened Nodosariæ, by the backward growth of the sides of the chambers and further compression, gradually pass into Frondicularia; see Quart. Journ. Geol. Soc. xvi. p. 453, pl. 19. Lingulinæ are not very common in the Cretaceous formations. The specimen figured (Pl. XV., Fig. 14, 15) is a remarkably fine individual (magnified six times) from the Chalk of Gravesend. Fig. 14 shows the slit-like aperture.

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* See "Memoir on Textulariæ," by Messrs. Parker and Jones, Annals of Nat. Hist. February 1863.

† For the description of the genera Pulvinulina and Planorbulina, see Carpenter's 'Introduction to the Study of Foraminifera' (Ray Society), 1862, p. 200, 210, etc.

Fig. 16, 17. FRONDICULARIA ARCHIACIANA, *D'Orbigny.*

A narrow form of *F. complanata*, Defrance, of which there is an endless series of modifications. These are really chevron-chambered Nodosariæ. Frondiculariæ are common in the Gault, Chalk-marl, and Chalk, and occasionally are found abundant in the Tertiary beds, and are not wanting in some parts of the existing seas. Fig. 17 is an edge-view.

Fig. 18, 19. VAGINULINA COSTULATA, *Reuss.*

A variable Nodosarian form, abundant in the Gault and Chalk-marl; rare or wanting in the Chalk. Fig. 18 is a view of the edge, which is as variable in thickness as the shell is in its other measurements.

Fig. 20, 21, 22. FRONDICULARIA CORDAI, *Reuss.*

Frondiculariæ, or flattened, chevron-celled Nodosariæ, vary continually as to the length of the backward elongations of the cells, as the two figured specimens (from the Chalk-marl or the Gault) here show. When they commence with a spiral arrangement of the cells, they are known as Flabellinæ; and excepting in this point, there is little or no distinction between Fig. 20 and D'Orbigny's *Flabellina rugosa;* indeed Fig. 22 shows a little eccentricity of the first chamber. Frondicularia is to Flabellina as Nodosaria is to Marginulina and Vagulina. Fig. 21 is an edge-view.

Fig. 23, 24. DENTALINA GRACILIS, *D'Orbigny.*

A variety of the world-wide *D. communis*, D'Orbigny, which occurs in all geological formations from the Palæozoic upwards. *D. communis* itself is a feeble form of *Nodosaria Raphanus.* Fig. 23 is the end-view, showing the aperture.

In the above remarks I have incorporated much information derived from my friend Mr. W. K. Parker.

CORRESPONDENCE.

Causes of Cosmical Changes of Temperature on our Planet.

That the vine, the walnut, the plane-tree, etc. etc., once flourished within the Arctic Circle, and that Mount Lebanon was for a long period covered with ice and snow, are facts inexplicable by any meteorological causes now in action, every geologist of the present day I believe admits. The question is to what causes, not now meteorologically evident, are we to attribute the great changes of temperature on our planet, which have extended over such long periods as those recorded by the unquestionable and well-established testimony of glaciation. Must we carry our solar system into remote regions of space in order that we may theorize on cosmic changes of temperature, or can we explain these truly wonderful facts by some changes in our own planetary motions, such as our earth getting into a zone of asteroids, to changes in the sun's atmosphere, either as to surface or intensity, as already published by Mr. Mackie, in a former number of the 'Geologist'? With regard to the theory of the earth passing through hot and cold regions of space, Mr. Mackie asks, "If heat be confined to matter, how can we speak of hot and cold regions of space, where by that very admission neither heat nor cold can be?" The reply to this question is not difficult. Matter cannot exist without space, but space can exist without matter. By hot and cold regions of space, I could only mean those portions of space occupied by matter, for where there is no matter there could be no temperature, neither hot nor cold as sensations, nor caloric as a material condition; for whether heat be a fluid or a wave, it can have no existence in pure space, pure space being a negation of everything that is material. The thermal portion of space must therefore be material that is occupied by matter. There can be no absolute void or pure space between us and any visible star, no matter how remote; even though its distance be so immense that the courier ray that now announces to our senses its existence, may have started on its errand thousands of millions of years ago, travelling all that time at the rate of a hundred and seventy thousand miles a second, still in the immense, the inconceivable space so run over by the luminous messenger, no absolute void could have existed, otherwise the star must be invisible to us.

Mr. Mackie is therefore right in stating "that if heat be confined to matter, how can we speak of hot and cold regions of space?" but he should have added pure or empty space where no matter exists, as I only meant those portions of space occupied by matter surrounded by and floating in a thermal ocean; for whether heat be a fluid or a wave, we cannot expect to find the causes of telluric changes of temperature by travelling into regions of space where nothing exists, where there is no entity but nought, "where death is life." Mr. Mackie says (last number of 'Geologist'), "if the sun moves on with his surrounding worlds, these will all travel onwards together in the same ethereal material envelope; and therefore, unless the supposed hot and cold regions of space have temperatures of much higher or much lower degrees than the general temperature of the solar region, the effect would be imperceptible." It is evident that the portions of space so traversed by our solar system at the rate of 57½ miles a second, moving towards the constellation Hercules, must be material, for so far as we can see any object in the universe, between us and that object there can be no absolute void or pure space, otherwise it must be invisible. Now it is clear that the regions of space occupied by matter cannot be of the same temperature, as the causes that generate light and heat are neither uniform in intensity nor distance. The path traversed by our solar system in space therefore cannot be isothermal.

It is not likely that our solar system is travelling through space surrounded by the same ethereal envelope, as Mr. Mackie seems to think, for this would be, supposing that outside this ethereal envelope nothing existed but pure space, an assumption quite opposed to the facts and reasons already stated. Besides, whether heat be a fluid or a wave, in either case it must be subject to the ordinary influences of physical agencies; therefore the same condition of matter constituting uniformity of temperature could not follow and surround our solar system in its travels through space.

David Leslie, M.D.

Tunbridge, July 19th, 1863.

The Portland Fissures.

Sir,—I hope you will allow me to correct a mistake which you have made in your remarks on my last letter, in saying that my theory was that of "the deposition of the extinct animals in caves before the caves existed." On the contrary, I said that I was of opinion that all bone-caves were only formed by the animal remains embedded in the limestone deposit before its consolidation, and, consequently, before the existence of any caves in it.

The question with respect to the Portland and Oreston fossils is entirely dependent on the truth of certain facts. First, with respect to the Portland fossils, can the statement of Captain Manning, of the 'Willis's

Current Notes,' and of the article in the 'Times,' relating to the new fortifications in Portland, be disproved, that human and animal bones have been found mingled together in fissures of the rock which do not extend to the surface of the rock? If this statement is correct, as I believe it to be, it necessarily follows that the human and animal bones must have been embedded in the calcareous deposit when it was soft, and consequently before the existence of fissures in it; and the men and animals to whom the bones belonged must have previously inhabited some other dry land which probably no longer exists. Again, if the assertions of Dr. Buckland, in the 'Reliquiæ Diluvianæ,' and of Mr. Joseph, mineralogist, of Plymouth, in his letter to me, are correct, that the caves at Oreston, which were only discovered by working away the body of a rock in a quarry, had no apertures, it necessarily follows that the animal remains must have been embedded in the calcareous deposit before its consolidation, and consequently before there were any caves in it, and therefore the animals must have previously inhabited some other dry land. I think it is certain, from the statement of Dr. Buckland, that all bone-caves which have been discovered with apertures through which the remains of large animals could have passed are situated in the face of cliffs, produced, as he says, by diluvial denudation, and that all other caves have only been "laid open by the accidental operations of a quarry or mine." He says, "the existence of caverns is an accidental occurrence in the interior of the rock, of which the exterior surface affords no indication when the mouth is filled with rubbish and overgrown with grass, as it usually is in all places, excepting cliffs and the face of stone-quarries;" that is, in fact, where no mouths have existed but what have been made by the formation of a quarry. For instance, as stated by Dr. Buckland, the bone-caverns in Yorkshire, Devon, Somerset, Derby, and Glamorganshire "were all laid open, with the exception of the caves at Paviland, by the accidental operations of a quarry or mine." The caves at Paviland are in the front of a lofty cliff, produced, according to Dr. Buckland, by diluvial denudation, and there is no evidence that they ever had any other mouths than those which were made by the formation of the cliff.

Your obedient servant,
THOS. D. ALLEN.

Rectory, North Cerney, Cirencester, July 9th, 1863.

[It is perfectly futile to argue upon such bases as Mr. Allen persists in bringing forward. Men who, like myself, have useful duties to perform in life, cannot waste their time in arguing on imaginary bases. Mr. Allen's fundamental base of argument, if not absolutely false, as I and every rational man in the present state of science must believe it to be, is unfounded and unproven. There is *no proof whatever* that the fissures do not extend to the surface: indeed the very good observations of Mr. Fisher distinctly show that they *do extend* to the very surface. Nobody denies that human bones and mammalian bones have been found in the fissures. So have halfpence with human and other bones in caves; but such an association would only lead to an erroneous inference if the circumstances of the association were not examined and explained. If this were not done, we might infer that the mammoth was a contemporary of George II. We really will not print any more "ifs." We distinctly challenge Mr. Allen to prove that the fissures at Portland do not extend to the surface, and, until this is done, we will print nothing more from him on the subject. The theory of the formation of caves by the generation of the gases of decomposition of animals embedded in soft mud is too absurd to attack, —for the volume of gas so generated, if powerful enough to have forced open any large body of earth in forming a cavern would have formed a spherical cavity or gigantic bubble. No such gigantic bubbles of air could ever have formed long, narrow, irregular, flat fissures such as those of Portland. In some of the German caves it has been calculated, from the bones extracted, that they belonged to three times as many individuals as, with their flesh on, the cave could contain. And this and many other arguments have been used expressly by Dr. Buckland to prove the caves were inhabited by the fossil animals while they were living. Mr. Allen can never reconcile these facts with his bubble theory. As to caves having no mouths, it is certain they must have, or have had, if we find anything in their stomachs. It would be equally consistent to argue that the flies found in the crop of a swallow must have produced the stomach in which they were found as to argue that caverns could be filled by bones of beasts without any orifice for the beasts or the bones to get in by.—Ed. Geol.]

The Portland Fissures.

Sir,—Though I should be sorry to do anything which would prolong the discussion on the Portland ossiferous fissures, I am induced to notice a statement, by Mr. Allen, in your July number, p. 253; namely, that a Plymouth correspondent informed him "that there was no aperture in the cavern" (discovered at Oreston in 1859), "and that some of the bones were embedded in 'compact rock.'"

In some sense each of these assertions is correct:—

1st. The cavern when discovered certainly had no aperture; it was easy however to discover where there had been one. The so-called *cavern* was more correctly a *fissure*, originally open at the top; but which, after the receipt of its varied contents, had been closed up with coarse breccia, consisting of large angular masses of limestone, which, from time to time, had fallen in from above and become cemented with carbonate of lime.

2ndly. Some of the bones were embedded in stalagmite, which might truly enough be termed "compact rock," but could not possibly be confounded with the true limestone. The quarrymen invariably gave it the distinct local designation of "callis."

It is undesirable further to occupy your space, and indeed, it is unnecessary to do so, as this subject has already been discussed in your Journal. See 'Geologist' for 1859, p. 439, etc.

I am, truly yours,
Lamorna, Torquay, July 17th, 1863. W. Pengelly.

The Bone Spear-head from the Essex Coprolite Pits, figured in the 'Geologist' for 1861, *page* 558.

Sir,—As the remains of man or his works, in any geological formation, is one of the most interesting discoveries of the present age, no manufactured article of decidedly geological age, be it ever so rude, should be cast aside or consigned to the cabinet without there being first brought forward all the evidence possible as to its age and its origin.

Therefore when a specimen is procured, we should first show it to be one actually worked, and not formed by chance; secondly, prove from what stratigraphical formation it has been taken; and, thirdly, ascertain how far back in the scale of geological time this formation dates.

The specimen which induces me to make the first inquiry is a bone spear-head, which, about five years ago, I procured from a heap of coprolites belonging to Messrs. Rhodes, Smith, and Co., manure manufacturers, of Selby, along with sharks' teeth, *Fucus contrarius*, oysters, and various pieces of bone, all of which seem to be of the same geological age. This heap of coprolites had been got from the Essex Crag, but as to what depth and the exact locality in the deposit this specimen had been embedded I have been unable to ascertain. It was the reading over, about three years since, of the interesting accounts in the 'Geologist' of the discoveries of M. Boucher de Perthes, which first caused me to look closely over the specimens I possessed from the Essex beds, and I was at once struck with the form of this bone-weapon, as one being fashioned by hand and not by accident. It seems to have been struck from the shank bone of some large animal, and in form somewhat resembles the large flint-pointed implements from Abbeville, and is nearly of the same size. Its length is $4\frac{7}{8}$ inches, and breadth $2\frac{3}{8}$ inches.

Believing this specimen to be a true worked one, I will endeavour to prove that it is a true fossil, and of the same age with the coprolites with which it was found. Its colour and density are the same as those of the teeth, shells, and other bones; it gives, also, the same metallic ring or clink when struck. Its point and edges are a little rounded down and polished by the action of water, as are the various other phosphatic specimens taken from the same formation. It is marked with slight scratches or striæ, particularly on one of its sides.

On the third point, I am not sufficiently acquainted with the Essex coprolite-beds to make out their exact stratigraphical age; yet, by the little I have learnt, I am led to think that this specimen, if a truly worked one and of the age of that deposit, is the oldest example known, and may probably carry the age of man nearly as far anterior to the specimens found in the gravels of Abbeville as those specimens date from the present time.

This is an interesting inquiry and worthy of further research; and I trust that the noticing of this specimen will be the means of further examples being procured *in situ* from the same formations.

Yours,
J. R. MORTIMER.

Fimber, Yorkshire, July 15*th*, 1863.

FOREIGN INTELLIGENCE.

An able article on the former connection between Northern Africa and Southern Europe was communicated, by Professor Edward Suess, to the meeting of the Imperial Geological Institution of Vienna, on the 20th of January last. We have deemed it sufficiently important to translate:—

A letter addressed lately by M. Anca, of Palermo, to M. Senoner, affords me the opportunity of returning again to a subject which I have already treated on, some time ago,* and the reconsideration of which seems to me very proper, not only to show the value of the studies of M. Anca, but the importance also of such researches in respect to the observations which are now being undertaken at Vienna.

I mentioned in my former article that the researches of my distinguished professional colleague, M. Hörnes, on the fossil mollusca of the Vienna basin, showed the unexpected concordance of many species of our marine fauna with those which are now living on the coast of Senegambia; and

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* Meeting of the Imp. Acad. of Sc., January, 1860, p. 159.

I quoted then as a few instances the *Cypræa sanguinolenta, Buccinum lyratum, Oliva flammulata;* and I inferred, according to my notions of the Great Sahara, that there was at one time a sea extending from the Gulf of Gabes southwards as far as the heights of Idijl, in the province of Aderer; thus uniting the Senegambian shores with those of the Mediterranean. I was able even then to refer also to the detailed statements of M. Laurent,* who had been commissioned with the construction of artesian wells on the northern border of the desert, and who, in his report, unhesitatingly represents the desert as having been once widely inundated as a sea-gulf, which broke in through the Gulf of Gabes, and the unmistakable traces of which are still to be seen by the numerous terraces along the southern border of the Aoures Mountain, where the ancient seashores can even now be recognized by the presence of one of the most common inhabitants of the Mediterranean, the *Cardium edule,* the shells of which are there scattered abundantly, and which mollusk seems even yet to be found still living in some solitary pools in the desert. I added further, that even at present large extents of the desert are situated far below the level of the sea, and that from the oldest times the extensive salt-crusts and salt-marshes have been considered evidences of a former overflowing of the sea.

With the progress of M. Hörnes' labours, the impression of the correctness of these statements has increased. We have been not only made acquainted with many species amongst the bivalves, which now extend their propagatory circuit as far as Senegal,—such as the *Lutraria oblonga, Tellina crassa, T. lacunosa, Venus ovata,* and three out of four of our Dosiniæ, namely the *Dosinia exoleta, D. lineta,* and *D. Adansoni,*—but we find also in our basin special and very marked Adansonian types, which at the present time are only to be found living on the Senegambian coast, as, for example, the *Tugon anatina* and Adanson's vagal, the *Tellina strigosa.* The great *Mactra Bucklandi,* also, which does not live on the European coast at all, seems to appear on the Senegal.

All accounts of the desert agree in the supposition of a former overflow; and not only Laurent, but also many other naturalists, independently of palæontological data, were led to this conclusion solely by the configuration of the district and the constitution of the soil. Barth, on his journey from Tripoli to Murzuk, in following the old Roman road, seems to have moved almost always eastwards of and outside the range of the ancient sea; it might not, therefore, at a future time, be without interest to investigate how far the outlines of this old sea correspond with the statements of Duveyrier on the limits of the country.†

The present land-fauna of Morocco and Algiers, as far as Cyrenaica, corresponds entirely in its essential features with the South-European, namely, on the one side with that of the Pyrenean peninsula, and on the other with that of Southern Italy; whilst in Senegal, Gambia, and the other countries beyond the desert to the Nile, the first really African types appear. The elephant, rhinoceros, hippopotamus, giraffe, crocodile, and many other principal forms, do not overstep the Sahara; and the contrast between the Morocco-African land-fauna, and the proper African fauna is, in most classes of animals, very striking, whilst the connecting links with Europe are unmistakable. The voyage of M. Mor. Wagner in the regency of Algiers‡ contains numerous proofs of this, and these are multiplied at every fresh comparison. The crossing of the *Inuus ecau-*

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* Bull. Soc. Géol. 1857, t. xiv. p. 615.

† Petermann, Mitth. 1861, t. xiii.

‡ 3 vols. Leipsic, 1841.

datus over to Gibraltar is known. The *Sorex Etruscus,* otherwise an exclusively Italian animal, is to be found in Algiers; the fox, which is lighter in Italy than in Germany, appears in Algiers as a still lighter variety; and it may be also worth mentioning, with respect to the reptiles, which are less exposed to the influence of man, that the new 'Erpetology of Algiers,' by Strauch, contains well-known South-European species, such as *Cistudo Europæa, Lacerta viridis, Tropidonotus natrix, Rana esculenta,* etc.; and that animals like the *Chamæleon Africanus* appear also in Spain and Sicily. With regard to the beetles, Erichson, having examined the collections of Mor. Wagner, says:—"A number of species belong also to the middle-European fauna; a larger number extend over all the coast-lands of the Mediterranean Sea, a few inclusive, but the most of them exclusive of Egypt, which, in its fauna, exhibits more of the middle-African characteristics. Most of the species possessed by Algiers are identical with those of the opposite Italian islands, Sardinia and Sicily, but less so with the mainland of Italy; and the same is the case with the Spanish peninsula and the opposite territory of Morocco; whilst it is very often the case that the Spanish-Morocco and the Italo-Algerian species show (?) comparatively an analogy between themselves."* The like phenomena are repeated in the land-snails. According to Forbes, the concordance of the Morocco snails with those of Spain is so great, that even on the heights the Spanish mountain-snails appear. The *Glandina Algira* is to be found, in the smaller form, from the valley of Tsonzo to Constantinople; whilst the larger variety connects Lower Italy, Sicily, and Algiers.† Other South-European species which seem to have originated from the east,—as, for instance, the *Cyclostoma elegans,*—are, on the contrary, wanting in Algeria; whilst the *Cyclostoma sulcatum* appears in the Italian islands, at Malta, in Southern France, South-eastern Spain, and also in Northern Africa. It seems also that all the South-European river mussels are to be found in Algiers.‡

With regard to the vegetable kingdom, and in order not to multiply excessively examples, it may suffice to record here the *Chamæros humilis,* and its scattering over the coasts of the Mediterranean Sea.

After all that it is not surprising that Andr. Wagner, supported by another series of arguments, so far back as the year 1846 wrote:—"The Mediterranean Sea, in a natural-history point of view, separates the northern border of Africa in a far inferior degree from Europe, than it is on the other hand separated by the Sahara from the principal stock of the African continent. According to all accounts the Sahara was once overflowed by the sea, owing to which Barbary became one of the Mediterranean islands."§

The present land-fauna teaches us to consider the Canary Islands, Morocco, Algiers, and South-western Europe, as a formerly connected continent, which, according to Forbes, probably extended as far as Cornwall. We call his fauna the Lusitanian fauna. We shall now proceed with M. Anca's communications.

In the year 1860, M. Anca made known|| his discovery in some bone-caverns in Sicily, of a quantity of determinable animal remains, which were accompanied by land- and sea-shells of species still living in that country,—as the *Helix aspersa* and the *Cardium edule.* The richest list,

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* Arch. f. Naturgesch. vii. Jahrg. 2 Bd. p. 153.

† Marteur, Würtemb. Jahresh. xi. p. 244.

‡ Ibidem, pp. 249, 257.

§ Transactions of the Royal Acad. of Sc. Bavaria, ii. cl. iv. vol. ii. sect. p. 11.

|| Bull. Soc. Géol. p. 680.

that of the grotto of San Teodoro, contains, according to Lartet, the relics of the spotted hyæna, bear (*Ursus arctos?*), wolf, fox, porcupine, rabbit, *Elephas antiquus?*, *E. Africanus?*, hippopotamus (one or two species), *Sus* (probably *Sus scrofa*, similar to the North African), ass?, oxen (two forms), deer (one or two species), sheep (or a similar animal), a large toad, and a bird. A recent letter of M. Anca confirms the appearance of *Elephas Africanus* in this grotto; whilst *E. antiquus* belongs to another stratum.

Thus we have close to species of European types,—as, for instance, the deer and the bear, which are strangers to Southern and Eastern Africa, and of which even Morocco and Algiers possess but a few representatives (perhaps only fossil bears in caverns),—a few of those animals which at present do not overstep the dominions of the desert, namely the African elephant and the hippopotamus; and with these, not the striped hyæna, which lives in Northern Africa and Upper India, but the spotted hyæna, the home of which is South and West Africa, the territory of the Nile, and Abyssinia. The Sicilian caverns show, also, a contact of South-European with true African types, which, owing to the interference of the Sahara, cannot be anywhere seen at this time.

These facts acquire the more importance when we add, that similar points of contact can be shown in Spain, from the period when the most prominent types of both faunas first existed. Moreover, it ought not to be overlooked that Cuvier searched for the nearest representatives of our diluvial fauna in Southern Africa, and even at the Cape; and that the fauna of Pikermi and Battavár, rich in antelopes, bears a distinct African character.

It cannot be stated at the present time, even conjecturally, in what way and through what causes the disappearance from Europe of the many groups of existing African forms, so long indigenous over our part of the world, was effected. M. Anca tells us, that even during the existence of the present faunas, there was a connection; and, as a first hint of such a connection, we have to fix our attention upon the submarine ridge reaching from Sicily to the opposite African coast, and which, Admiral Smyth states, encompasses the extensive plateaux of the "Adventure-bank," and the Skirki cliffs, which seem to be the submerged area of Virgil.

But, although the order of events which caused these changes appears as yet very obscure, we are nevertheless able already to distinguish amongst the present population of Europe, not only a number of certain independent groups of organic forms from which that present population of Europe has originated, but also to indicate the succession in which they appeared. The first group, still discernible, is that which we shall call the African; it was completely displaced long ago, and its last vestiges in Europe are shown to us by M. Anca. The second is the Northern group, the remains of which are still living on our high mountains, forming a higher zone above two others which occupy lower levels. These lower groups are, on the one hand, the western fauna, which we term the Lusitanian, the recognized types of which are the forms common to Northern Africa and Europe; on the other hand, the eastern fauna, which we may perhaps call the Asiatic, and which is subdivided into many members dependent on physical differences,—as, for instance, those which exist between the Caspian steppes and Asia Minor.

It is not our purpose to show here the relation of the various zones of special faunas in the European Seas; but we are bound to observe that the mollusca quoted above as being common to Vienna and Senegambia, as the *Trigonia anatina*, must have once undoubtedly inhabited some part of the present Mediterranean Sea eastwards of Sicily; and that they became extinct probably at the time of the diluvium, and never since have been able to recover their place. It is true, as Mr. M'Andrew teaches us, that many tropical species,—as, for instance, the *Cymba olla,*—favoured by the current, cross through the Straits of Gibraltar over to the North African coasts; but they do not penetrate far enough, and besides, the character of the Mediterranean fauna is quite different from that of Senegambia.

Climatal variations are generally considered the essential causes of all such displacings of land and sea faunas and floras; and many distinguished naturalists, influenced by the great effects they have witnessed of the south wind on the glaciers in Switzerland, have been induced to attribute to it the melting away of the formerly larger extents of those ice-masses. Thus, also, they have arrived at the same result which, as we have seen, has been attained by the palæontologist, the geologist, and the animal geographer, each following different roads, namely the conclusion that the Sahara, the source of the south wind, was once covered with water. On the heights of continental Europe a stronger climate might probably have been produced; but in a continent dissolved into an archipelago, as we can imagine it to have been at the time when the present Senegambian shell-fish lived near Vienna, a lower temperature, at least in the sea, could certainly not have been produced, and the whole archipelago enjoyed undoubtedly, notwithstanding the want of a south wind, a moderate sea-climate.

Many questions and many doubts still force themselves on our mind; but at all events we can at least already foresee the way to study through the creations of the present those of the past, and through which we may arrive at a more perfect understanding of the repeated changes of the organic world.

The Count Marschall of Vienna has kindly sent us the following excellent notice of Dr. James R. Lorenz's admirable and valuable work on the 'Physical Condition of the Gulf of Quarnero, and the Distribution of the Organic Beings living in its Waters:'—

This book, published at the cost of the Imperial Academy of Sciences, is based on the results of six years of assiduous local observations made by the author, who holds an eminent place amongst the younger generation of Austrian naturalists. The title in itself shows these investigations to stand in close relation with those made by Oersted on the Oeresund and by the late Edward Forbes on the Ægean and the German seas, especially concerning the distribution of submarine organisms (both plants and animals) within certain regions of depth and the influence of physical conditions on their modes of existence; while Sars, Asbjörnsen, and M'Andrew have merely brought under consideration the mode of distribution of marine animals, without a special regard for the physical conditions under the influence of which they exist. Dr. Lorenz's book, however, is in certain points of view essentially different from those by Oersted and Forbes. The physical conditions of the Gulf of Quarnero, which covers a surface of about one geographical degree square, are treated in detail in the first section of the book, which may, in itself, be regarded as a complete hydrography of this portion of the Adriatic. Such a thorough investigation of these conditions may be considered a real progress, to be expected from the rational use of a sequential method. What, after all, are the regions and zones to be distinguished in the horizontal and vertical distribution of organic beings but spaces, within whose limits the essential characters of these beings remain unaltered? Wherever these characters undergo decided alterations, or the hitherto prevailing types are superseded by others essentially different, a new region or zone must be said to begin. This constancy of character among the organic inhabitants within determined vertical or horizontal limits, could not take place if certain external circumstances were not vital conditions for a great many organic beings, whose existence can only be continued and propagated under a determinate combination of physical agencies or whose power of natural selection and its results (to speak in the sense of Dr. Darwin's hypothesis) is essentially dependent on these agencies. At all events, organic beings consociate in those spaces within which they find the means of satisfying their special conditions of existence. These conditions for marine organisms are :—the nature of the sea-bottom, the temperature of the sea-water, its saltness, its permeability to light, its pressure, undulations, currents, and tides ; just the objects to be treated in a physical geography of the sea. The distribution of marine organic life can, of course, only be thoroughly understood by the aid of hydrography. This branch of science may however turn into profit the results of organographic investigations, as being indicative of certain hydrographical conditions, which, without them, could only be stated by means of a long series of observations, and must consequently, in certain cases, remain far behind the special purposes to be attained by them.

Professor Lorenz, in the course of his investigations, took great care never to lose sight of the intimate connection existing between hydrography and organography. The introductory part of his book begins with an exposition of the mode of action of each single agent. He proves the depth, generally considered, according to Edward Forbes, to be in itself a condition of distribution, to act only as a combination of other factors. In the following chapters the author discusses each of the above-named factors, in itself and in its connection with others, basing his comments on his own numerous observations in the Quarnero.

The factors depending on the solid basin containing the sea and the atmosphere in immediate contact with its surface,—that is, the geographical, bathymetrical, geological, and meteorological conditions,—are first brought under discussion. A very instructive map, partly of chromotypic execution, serves to illustrate the variations of depth and of the nature of the bottom, both in open sea and along the shores.

In the chapter on climatic conditions, in many respects depending on those of the neighbouring continental regions, the author expresses his remarkable views on the mutual connection between wind and weather, shows the origin of certain winds regulating the march of weather, and derives from their nature a series of typical atmospheric conditions (Bora, Scirocco, Maëstral, Tramontana, and Provenza weather), with their prognostics, courses, distributions according to seasons, etc. The explanation given by him of the "habitual Bora," with its characteristic blasts of wind (Repoli), is particularly of scientific and practical interest. According to Dr. Lorenz's observations, the north-east wind passing over the high and steep slopes of the Karst is innoxious in itself, whether it comes from inland regions, or originates over the plateau of the Karst by local compensation between two atmospheric currents different in density or temperature. It acquires only a dangerous intensity whenever a scirocco, blowing in opposite direction to or a little above it, presses it more or less violently against the plateau of the Karst and forces it into a narrower space. Besides this normal Bora, two other varieties of it, of non-dangerous nature and of different origin, are known to exist.

The waters of the Quarnero contain salt in an average proportion of 3·76 per cent., their density is $=1·023$ at the surface and $=1·0275$ at

20 to 40 fathoms depth; both these conditions vary with the seasons and the weather.

In the chapter on optical conditions, the author states the distinction between the specific coloration of sea-water and the tints due to reflection of surrounding objects; the dependence of the specific coloration on depth, purity, and transparency of the water (as proved by a great number of measurements); and the intensity and tints of light as it penetrates into greater or less depths. When discussing the undulatory movements, the author pays special attention to the nature and intensity of breakers, as determined by the conformation of the sea-bottom and of the shores; as also to currents, their velocities and depths, and their dependence on the direction and intensity of winds or on unequal distribution of atmospheric pressure and of evaporation.

Level-observations, continued during a series of years and occasionally far southward along the Dalmatian coast, have led our author to a number of very peculiar, and indeed unexpected results concerning the tides of the Quarnero. Within the eastern longitudinal half of the Adriatic, high water and low water take place only once in twenty-four hours, their times of beginning not retrograding daily with the culmination of the moon, but retarded only two hours in every month, so that within twelve months the tides return again to their original periods. The facts being at complete variance with those hitherto admitted, Dr. Lorenz thought proper to give a graphical representation of a long series of his personal observations by means of curves, which he calls "actiographical," as being indicative of the causes acting on tides. The average sea-level is chosen for a line of abscissæ: the curves rising above or sinking below the line mark the epoch and intensity of tides; their tracing (thick, thin, punctated, streaked, etc.) is indicative of the simultaneous state of weather and wind. Every diurnal curve bears the date of the corresponding day and lunar phases, and is partly accompanied by the corresponding barometrical curve. This synoptical representation of tides and causes acting on them, shows that none of the above-named factors, nor interferences, friction, and other causes of retardation, are the ultimate causes of this peculiar march of these tides, although they may modify it within precise limits. The ultimate cause may only be ascertained by tidal observations extended through the whole length of the Adriatic and the Mediterranean; the phenomenon itself is a duly-stated fact, and Dr. Lorenz has made it the basis of a tide-calendar for the Quarnero, with every connection for secondary influences acting on the times of beginning and the intensity of tides.

The physical part of Dr. Lorenz's book ends with the discussion of temperature as influenced in many ways by all the other factors. Nearly 200 measurements have been taken, either at regular periods, in determinate places, and in constant depths (surface, 10, 20, and 40 fathoms), or occasionally to serve for special purposes. The results of these observations are highly interesting. They give, not only the average temperature of water in the above-mentioned horizons, but also the progress of temperature within them during the course of each season. Their graphic reproduction by means of curves distinctly exhibits the retarded influence of seasons, the diminution of difference between the maxima and minima, and the general depression of average temperature with increasing depth (about 1° R. for each 10 fathoms). The influence of the sea-bottom, of fresh water, etc., on the temperature of shallows, is brought under discussion; and the affluent fresh waters are shown, by observations of temperature, to form a very thin but far-spread stratum on the surface of the heavier salt-water.

It may be inferred from this succinct analysis of the physical part of Dr. Lorenz's book, that it is, in itself, and independently of the organographical division, a highly valuable contribution to our knowledge of archipelagic hydrography. We must wish, therefore, to see the author pursuing the plan, traced out in his epistolary communications, for stating the essential, numerous, and practically interesting differences between the simple conditions of oceanic and the far more complicated ones of archipelagic hydrography. The organographical division begins with introductory remarks on the method of investigation and the way of discussing their results. It is proved to be more adequate and conclusive not to begin with the statement of regional limits, but rather to state regional maxima, from which the organic types most evidently consociated within the maximal strata may be pursued in ascending and descending directions as far as to their extreme limits. Animal and vegetable forms must not be promiscuously used for regional elements, as it has been done by Oersted and partly also by E. Forbes, the plants following, in their distribution, quite different laws from animals, the maximum of their diversity of forms and their total disappearance taking place in depths entirely different from those of animal organisms. The purpose of the method followed by the author in the description of each region is, to give a complete physiognomical and actiognomical idea of each of them as to their causes, so as to serve as points of comparison for future similar investigations,—a purpose not attainable from the majority of the hitherto published marine faunæ and floræ, these being generally mere enumerations of species.

The detailed descriptions begin with the marine plants of the Quarnero. Every region is accompanied by special details in respect to its physical conditions, founded on careful local investigations. By this method, the simple mention of the depth in which any organic being is living is quite sufficient to give an exact notion of the whole of the external agents under which it exists, and which, more or less, are determinative of its habitat.

Within every region of depth organic beings are consociated in distinct groups, as far as the conditions, not essentially connected with depth and consequently diversely distributed within one and the same stratum of depth, as the nature of the sea-bottom, currents, and, in higher strata, undulatory movements, affluence of fresh water, etc., are more or less favourable to their development.

These groups distinguishable within each region are called "*facies*." The author enumerates forty-one of such facies within the six vegetable regions of the Quarnero, and names them according to the genus prevailing among them, Callithamnetum, Cystoseinetum, etc.

A table of distribution enumerates the vegetable species in systematic order, each with the corresponding number of its region, and its horizontal range in other seas. A comparative synopsis of the vegetable regions of the Quarnero and of those of other seas, shows Oersted's book on the Oeresund to be still the only extant work on marine plants and their distribution which may afford profitable comparative results.

The seven regions and thirty-two facies of the Quarnerian animals are treated on the same plans as those for vegetables, both of them standing frequently in mutual dependence.

The table of distribution of animals gives a comparative view of the depth at which the same species have been found in other seas by E. Forbes, Oersted, and M'Andrew, and of their horizontal range, as far as yet ascertained.

Also for the animals a comparative synopsis again proves the results obtained by E. Forbes and Oersted to be the only ones fit for profitable comparison.

The elaborate data from which the laws of vertical distribution of marine organisms may be inferred with any degree of security being so extremely scarce, we must admit Dr. Lorenz's book to be a highly valuable contribution to this branch of science; the more so as he, working on the few classical investigations of his precursors, has really added new riches to our scientific stores.

This book, although not directly connected with geology and palæontology, as E. Forbes's investigations were in their time, nor published with any view to the practical purposes of propagation and acclimatization, may be profitable notwithstanding to each of those branches, as it offers a rich store of thoroughly discussed facts whose influence on extinct animal forms was certainly not less than it is still on those now living.

Even plain good sense, unassisted by science, can comprehend how from investigations of this nature, that only by following the still-neglected paths of physico-organographical researches profitable results may be achieved concerning the rational culture and multiplication of useful marine productions.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Dudley Geological Society.—In a paper read before the Dudley Field Club, Mr. John Jones, of Gloucester, has described some flint-flakes and the deposit in which they were found by Mr. E. Witchell, of Stroud.

In an excavation for a reservoir on the brow of the Oolite hills at that place, the superficial clay charged with land and freshwater shells rests apparently on land-slipped masses of Oolites and subjacent rocks, the total thickness of the clay being from 15 to 20 feet, and the elevation of the deposit 700 feet above the sea. The clay bed is said to be divided into an upper, middle, and lower portion. It is from the middle portion Mr. Jones records "flint-implements with cutting-edges (*i. e.* flint-flakes), carbonized wood, Oolitic stone changed in colour by the action of fire, the bones of animals, a portion of a deer's antler, apparently that of the red deer, and what, from the description of the workmen, who had not cared to preserve it, was probably a boar's tusk, all in close proximity." The shells found in the clay are various species of *Zonites*, *Helix*, *Pupa*, *Succinea*, etc.; such, as Mr. Jones says, have been found fossil at Grays, Copford, and Clacton, and as he gives a list of the mammalia found at those places, we presume he is disposed to infer the same age for the Stroud clay: a conclusion we do not see borne out by the character of the flint-flakes, which are of prehistoric, but not geological age, according to the opinion of Mr. John Evans, who has inspected them. Mr. Jones's method of comparison with the organic remains from Grays and other beds for the age of this deposit is very curious, but in the case of mollusks is not, we think, practicable. The circumstances are, however, well recorded, and the author has worked together very nicely all the facts which have come to his knowledge in support of his views. The locality from which these relics have come would, if worked in an antiquarian point of view, afford, we think, many more interesting details, and we are glad to hear the proprietor intends carrying on further excavations. The paper is, like many others by Mr. Jones which we have already noticed, carefully worked out, and one properly adapted for the discussion of a field-club.

Manchester Geological Society.—Mr. Binney communicated to the Society a section of the drift deposits near Rainford, kindly furnished, with some fossil shells, by Mr. Bramall. That gentleman had forwarded him a section of the beds sunk through and the fossils found in them, just the kind of information which it is desirable for gentlemen to transmit to the Society. It is only by such information that we can hope to obtain a thorough knowledge of the drift deposits of Lancashire. He trusted that many other members would forward similar sections. The pit is near the Lancashire and Yorkshire railway, and the following beds were met with in sinking the shaft there:—

	yds.	ft.	in.
Soil	0	1	6
Marl	11	1	6
Loam	5	0	0
Wet Gravelly Clay	5	1	6
Quicksand	7	0	0
Gravelly Marl	1	0	0
	30	1	6

At a depth of 25 yards from the surface, in the wet gravelly clay and the sand, the *Turritella terebra*, *Fusus Bamfius*, *Nassa reticulata*, *Cardium edule*, *Tellina solidula*, *T. tenuis*, and fragments of other shells were found. He did not know the level of the place above the sea, but he should not estimate it much above 200 feet; and he had great pleasure in exhibiting to the meeting the beautiful and perfect shells which Mr. Bramall had been so kind as to send him.

2. Mr. Binney presented two maps of the parish of Manchester, coloured geologically by himself,—one showing the drift deposits, and the other the older stratified rocks found lying under such beds. They were made, in 1861, to illustrate a paper read by him before the Geological Section of the British Association. These maps he considered more as outline than complete maps, but they would be useful to show what was known of the district prior to the visit of the Geological Survey. All the particulars, both as to the drift and the older rocks, had been previously communicated to the Society many years ago, except in some few instances, where fresh borings and excavations had since been made.

In his paper entitled "Notes on the Lancashire and Cheshire Drift," read before the Society on the 23rd day of December, 1842, an abstract of which was printed in the Annual Report of the Society for 1843, he gave a classification of the beds into three divisions of lower sand and gravel, till or boulder clay, and upper gravels and sands, with occasional beds of till or boulder in them. Besides these three deposits, he described a fourth, in the gravels and sands found in the beds of the valleys and low lands adjoining rivers and brook courses, and evidently derived from the first-named deposits, such valley sands and gravels being formed during the erosion of the valleys through the three more ancient beds.

With respect to the older rocks, he said that when he came into the district some twenty-five years ago, the local geologists always considered the four-feet coal of Bedford, Worsley, Bury Lane, and Pendleton, to be the same as the Bradford four-feet.

In the sinking of Messrs. Knowles's shaft at Agecroft, the following section, kindly communicated by Mr. James Knowles, was met with:—

	yds.	ft.	in.
Soil, Sand, Clay, and Soft Metal	15	2	0
Rock	11	2	0
White Earth	1	2	0
Coal	1	0	1

	yds.	ft.	in.
Chitter	1	0	2
Rock	34	0	0
Blue Leys	5	2	0
White Earth	1	2	0
Iron Band	0	0	3
Rock Warrant	3	0	0
Rock Bands	3	0	0
Rock	3	0	0
Blue Leys	5	0	0
Iron Bands	0	0	3
Black Stone	0	0	5
Rock	2	0	0
Blue Leys	2	0	0
Black Bands	0	0	6
Rock	0	2	6
Warrant Earth	2	0	0
Rock Warrant	0	2	0
Blue Leys	1	2	0
White Earth	3	1	0
Black Bass	0	1	0
White Earth	1	2	0
Coal	0	0	6
Warrant Earth	2	2	0
Rock	0	2	6
Blue Leys	1	0	0
Rock	0	2	0
Blue Leys	5	2	6
Black Bass	1	0	0
White Earth	1	0	0
Black Bass	0	1	3
COAL, FOUR-FEET	1	2	0
	116	1	11

Although the common opinion was that the two coal seams were the same, there was not much evidence adduced in support of it. On taking the strata immediately above the Four-feet coal at Agecroft, Pendleton, and St. George's Colliery, Rochdale Road, Manchester, the two last-named points being about 2½ miles apart and the nearest we can find, there is considerable difference, both in the beds and their organic remains, as will be evident from the following sections:—

AGECROFT.

	yds.	ft.	in.
Blue Leys	5	2	6
Black Bass	1	0	0
White Earth	1	0	0
Black Bass	0	1	3
Coal	1	2	2

PENDLETON.

Blue Leys	7	1	0
Black Bass	0	1	0
Very Black Bass	0	0	8
Ironstone	0	0	2
Impure Cannel	0	0	3
Cap Coal	0	0	10
Fire Clay	0	1	4
Coal	1	1	0

The Agecroft section was about half a mile to the north-west of the Pendleton one. The same fossil fish remains, and the *Anthracoptera Browniana* of Salter, are met with in the impure cannel, black bass, and ironstone of both mines, although in much less abundance at the former than the latter.

Now at St. George's Colliery, Manchester, about 2½ miles in a straight line from Pendleton Colliery, the following is a section of the strata immediately above the four-feet coal:—

	yds.	ft.	in.
Rock Bands	3	2	0
Hard Gray Rock	5	0	0
Coal, called Nine Inches	0	0	6
Black Sod, Rotten	0	1	0
Impure Cannel Coal	0	0	6
FOUR-FEET MINE	1	0	6

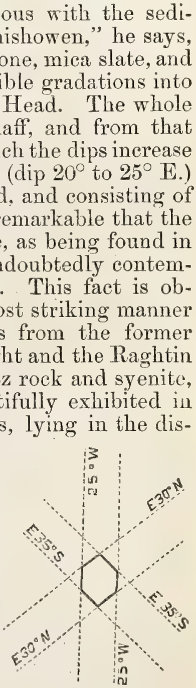
Not only is there a great difference in the nature of the deposits, but there is an equal difference in their fossil organic remains, few, if any, of the fishes being met with at Bradford which were so abundant at Pendleton. Until the sinking of the Patricroft pit by Messrs. Lancaster, and the proving of the Pendleton four-feet coal there, it was not easy to be convinced that the Bradford and Pendleton seams were the same; but when the author saw the red ironstone at Patricroft, he immediately identified it with a similar bed seen on the banks of the Medlock, below the brewery in Beswick. Now the last-named instance lies 366 yards above the four-feet coal of Bradford, as can be proved in the river section of the Medlock, between Beswick and the old ford across the river, just below the iron bridge near Philip's Park, where the "four-feet" outcrops. The distance is 1100 yards, and the dip of the strata, on an average, 1 in 3; so that will give 366 yards between the two strata. At Patricroft, the distance in the sinking between the four-feet coal and the red ironstone was 378 yards. From this, 20 yards has to be deducted for the dip of the strata, leaving 358 yards as the thickness; so one seam is within 10 yards' distance of the other,—no great variance in 5 or 6 miles.

By looking at the map it will be seen that the Trias covers the upper coal-field on its dip at Ardwick, and no traces of the Permian beds, which are known to be found under the south-east of the city, are shown at the surface. There is little doubt but that both the Trias and Permian beds rest unconformably on the upper coal-measures here, but they cannot be seen. Some time since, Mr. Mellor was so kind as to show him a soft red sand without pebbles, very like the Vauxhall sand, which had been met with in driving a tunnel to the dip of the Ardwick limestones. At first he was inclined to consider this sand as Permian, but he has since come to the conclusion that it is Trias, as no Permian marls are found above it. He had given, he said, twenty-five years to investigate the geology of Manchester, and the two maps, imperfect as they were, are the result of his labours. Younger geologists must take them in hand and improve upon them. There was plenty of work to be done before the geology of the district, six miles around the Manchester Exchange, would be all well known and correctly laid down. He hoped that the structure of the ground upon which the city stood would attract the attention of the members.

Mr. E. Hull said it was an excellent local map, and conveyed a very proper and correct notion of the general structure and principal features of the district of Manchester. He took a different view from Mr. Binney on one or two points, principally as to the formation to which the sandstone near the Ardwick limestone beds belongs. He could not see what objection there should be to insert a little strip of lower red sandstone of the Permian formation there. This he has done himself in the map published by the Geological Survey, and he thought the reasons for doing so outweighed those for the opposite course. He also considered that the Irwell Valley fault ought to be continued to the Mersey, at Heaton Mersey; and the eastern boundary fault of the Manchester coal-field to Stockport. Also, that there was a second bed of boulder clay lying above the sand and gravel; but in his general views on the subject of the drift, he fully concurred with Mr. Binney.

NOTES AND QUERIES.

The Granite Rocks of Donegal is a subject that has been taken up in a determinate and able manner by Mr. Robert H. Scott, the Secretary of the Geological Society of Dublin, and several valuable papers on it have been read by him, and have been published in the 'Dublin Quarterly Journal of Science.' He points out the very remarkable fact that the so-called igneous rocks of Innishowen are contemporaneous with the sedimentary rocks of that district. "In the north of Innishowen," he says, "the chief rocks observed were grits, crystalline limestone, mica slate, and a variety of greenstones and syenites, passing by insensible gradations into the two distinct types of syenite of Ardara and Horn Head. The whole of these rocks are contorted considerably about Culdaff, and from that to Malin Head they exhibit a consecutive section, of which the dips increase as you go westward, the beds being nearly horizontal (dip 20° to 25° E.) at Culdaff and along the shore towards Glengad Head, and consisting of grits, interstratified with igneous rocks. . . . It is very remarkable that the igneous rocks, to which allusion has already been made, as being found in great abundance in the county, in Innishowen, are undoubtedly contemporaneous with the sedimentary rocks of the district. This fact is observable along the coast, but it is noticeable in the most striking manner between Buncrana and Carndonagh, about five miles from the former place,—the whole of the hills lying between Slieve Snaght and the Raghtin mountains being composed of alternating beds of quartz rock and syenite, dipping at a low angle to the eastward. This is beautifully exhibited in the mountain of Binmore or the King of the Mintiaghs, lying in the district called the Barr of Inch, close to the Mintiagh lakes. This hill, with its consort, the Queen, form a very striking feature in the landscape, when seen from any point in the northern part of the county. . . . These hills and the mountain Bulbin are terraced like the trap hills of Antrim and the coast of Argyllshire; but on a close examination, it is found that, though the conclusions drawn from the terraced form are further borne out by the fact that all the beds are columnar, yet they consist of alternate beds of quartz rock and syenite, as before described. The columnar structure of the former is due to the simultaneous development of three series of joints, inclined to each other at angles approaching those of a regular hexagon. These joints are all of them traceable in other parts of the county; but it is only here that they assume a development of such equal importance.



Joints in King of the Mintiaghs.

"It may here be remarked that the types of igneous rock, which have here been deposited contemporaneously with the sedimentary strata, are found to be very similar to those of the intrusive rocks of other parts of the county, *e. g.* of Doonan Hill, close to the town of Donegal.

"On passing west from Buncrana towards Dunaff Head, through the Gap of Mamore, it is found that, as we approach the granite at Urrismenagh, the dip of the beds increases from 45° to nearly absolute verticality. The granite of Urrismenagh does not present many features of interest to the mineralogist, as the rocks in immediate contact with it are quartzose, and therefore unlikely to yield accidental minerals. . . . The chief point which is noticeable about the neighbourhood of Dunfanaghy is the extreme development of a highly crystalline syenite, containing a very large proportion of titaniferous magnetic iron. The octohedral crystals of this mineral are very noticeable on the weathered surface of the rock."

HYBODUS AND OTHER FOSSILS.—Dear Mackie,—A few notes on 'Geologist,' No. 67.—P. 241. Many specimens of shark-jaws much like, if not the same as, *Hybodus basanus*, certainly in similar state of preservation and matrix, occur in the *Wealden* beds near Hastings, probably in the middle portion of the Hastings sand series. Mr. Moore, of Hastings, and Mr. Beckles, have collected several specimens. The Wealden beds below the Perna bed (bottom of the Lower Greensand) in the Isle of Wight present about 100 feet of thickness above the equivalent of the Hastings sand; therefore, if occurring there in the equivalent of the Hastings series, the Hybodus may have been found perhaps on the shore not far from the junction with the Lower Greensand; nevertheless it may be truly a fossil from the latter.

Page 243, etc.—"Lias Bone-bed." You might as well give the proper term to this at once, "*Rhætic* Bone-bed" (or "one of the bone-beds of the Upper Keuper"). The Rhætic shales at Linksfield, near Elgin, are also rich with *Hybodus*. The Linksfield shales, at first thought to be Wealden, were referred by Morris to the Great Oolite, but are now regarded as Rhætic. See my monograph on Fossil Etheriæ, p. 77. *Sphenonchus Martini*, Ag., also from Linksfield, is regarded by Ogilvie and Charlesworth as the "frontal spine" of *Hybodus*.

Page 245.—In your list, after Morris, you should have kept *H. striatulus* to the Wealden. It would have been well if you had separated teeth from spines in the list.

Page 255.—"*Rhinoceros Etruscus*." I do not see this mentioned in M. Desnoyers' Memoir.

Page 267.—Why didn't you notice the fact of Sir P. Egerton and Mrs. Smith's specimens of *Dolichosaurus* being parts of one and the same specimen? See Dixon, Foss. Suss. p. 388, Owen's Monog. Cret. Rept. 1851, p. 22, and Medals, p. 712.

Page 268.—"Lower Greensand Reptiles." I believe that the little crocodile figured and described by Owen, Monog. 1851, p. 45, as in Saul's collection and from the "Lower Greensand, near Hastings," was from the *Wealden*. I saw it in Saul's collection.

Page 270.—"Lapis frumentarius." "Lapides frumentarii" are pieces of Nummulitic limestone, Alveolina limestone, and stone full of other Foraminifera, as the case may be, with different old authors. The sections of the Nummulites present occasionally seed-like appearances as well as small leaf-like objects, which latter gave rise to the terms "Salicites," "Daphnis," etc.; whilst the Alveolinæ, etc., were thought to be rice and other grain, as millet, fescue-grass, etc. Hence the names "Phacites," "Seminales lapides," "Lentes lapideæ," "Lapides cumini, frumentarii," etc.; besides "Lapides circulares," "Nummi lapidei," diabolici, "Nummularii lapides," "Lapides numismales," etc., for Nummulites. See Gesner, Langius, Scheuchzer, Mercatus, etc. The last-mentioned of these old observers has the following remarks on some "Lapides frumentarii," or "Pœcilospermi," as he terms them, in his 'Metallotheca Vaticani' (Michaelis Mercati Samminiatensis Metallotheca, opus posthumum, studio J. M. Lanciscii: Romæ; fol. 1719).

At page 285, "*Pœcilospermos.* Confertus siliquis agrestis cumini corniculatis, interponit alias in gyros convolutas, quales sunt Medicæ; nonnullas bifidas specie coluteæ, rimam agentes, per quam semina minuta ostenduntur." The locality of this specimen is not given; the figure indicates *Rotalia Beccarii*, *Peneroplis* (?), etc., in the stone.

At page 286, "*Pœcilospermos alius.* Huic sunt ferulacei generis semina, fœniculi, anethi, multaque minuta, quædam tritici, aliqua in gyros collecta, qualia diximus Medicæ, adjectis insuper hirculis, cauliumque sarmentis." This specimen is of a dull yellow colour, as is also the foregoing; the locality was not known. The Foraminifera in it seem to be Miliolæ, Rotaliæ, etc. Other specimens from Verona are then mentioned as being full of wheat, and it is observed, "ut videatur in eo necessitas vitæ nostræ ludibrium Naturæ debuisse."

The title of Langius's book, in which the *Lapides frumentarii* are mentioned and figured, is:—"Caroli Nicolai Langii, Lucernens. Helvet. Phil. et Medici, Acad. Cæs. Leopold. Nat. Curioss. German. et Physio-Crit. Senens. Historia Lapidum Figuratorum Helvetiæ, ejusque viciniæ, in quâ non solum enarrantur omnia eorum Genera, Species et Vires æneisque tabulis repræsentantur, sed insuper adducuntur eorum loca nativa in quibus reperiri solent, ut cuilibet facile sit eos colligere, modo adducta loca adire libeat." Venetiis, MDCCVIII.

At p. 69, etc., are described certain specimens which are figured on Plate 18; namely,—"Salicites Helveticus, niger, foliolis candidis" (a piece of Nummulite limestone). "Lapis frumentarius Helveticus, niger, semina melonum cumini cum conchitulis albis referens" (a piece of Nummulitic limestone). "Lapis frumentarius Helveticus, cinereus, semina melonum anisi fœniculi referens" (a piece of Nummulitic limestone). "Cenchrites" (Oolitic rock ?). "Meconites" (Oolitic rock ?).

Page 270, "Lapis piriformis" or "pyriformis."—Any *pear-shaped* curious stone would be sufficient for this. I have an excellent flint one from the Chalk.—Yours truly, T. R. JONES.

15, *Terrace, Yorktown, July* 14*th*, 1863.

[I used the term Lias Bone-bed as being the first given to it, and because I am not yet prepared to admit the deposit as a portion of the Keuper. I do not however wish at present to dispute its assignment to that formation. I am not a believer in palæontological determinations of the geological age of strata, and admitting the fossil organic forms in the Bone-bed to be Rhætic, it seems to me that they were cut off out of living existence by the commencement of the Lias deposits,—that is to say, the commencement of the deposition of the Lias strata was the period of the destruction of the Rhætic fauna. Does the presence of Rhætic forms under such circumstances take the Bone-bed out of its proper stratigraphical relationship to the Lias? Such are the reasons why I have called it Lias Bone-bed. I did not notice the Egerton *Dolichosaurus* as a portion of Mrs. Smith's specimen, although I was well aware Professor Owen had done so in his 'Monograph of Cretaceous Reptiles,' for the reason that Professor Owen records Mrs. Smith's specimen as from the Middle Chalk, while Sir Philip's specimen in the British Museum is decidedly Grey Chalk. Mrs. Smith's collection being no longer accessible to inspection, I preferred to leave the reputed association unnoticed. With regard to the "Lapis pyriformis," it seemed to me that many of the fossil sponges might be noticed under such a term, but it also seemed possible some of the larger flint-implements might have been so termed; and I thought the point worth mooting.—Ed. Geol.]

New British Mammals.—The following mammalia have been recorded as British since 1853, the year of the publication of the 'Bibliographia Zoologiæ' by the Ray Society, as new or as found within the British area for the first time, or in a deposit from which not previously recorded:—

Bos frontosus, Nilsson, sp. Recorded by Mackie as British, in 'Geologist' (1862), Vol. V. p. 441, Pl.

Bubulus moschatus, Owen (Pallas, sp.), *Pleistocene* (Lower Level Drift), Maidenhead, Berkshire; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 124, fig. 1–6.

Canis, sp., Owen, *Red Crag*, Woodbridge, Suffolk; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 227, fig. 22.

Canis, sp., Owen, *Red Crag*, Woodbridge, Suffolk; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 227, fig. 21.

Cervus dicranocerus, Owen, *Red Crag*, Sutton, near Ipswich, Suffolk; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 224, fig. 14–17.

Dichobune ovina, Owen, *Upper Eocene Marl*, Isle of Wight; Quart. Journ. Geol. Soc. (1857), vol. xiii. p. 254, pl. viii.

Dichodon cuspidatus, Owen, *Upper Eocene*, Isle of Wight; Quart. Journ. Geol. Soc. (1857), vol. xiii. p. 190, pl. iii.

Elephas (all the British species), Falconer, in Quart. Journ. Geol. Soc. (1858), vol. xiv. p.

Equus (*Hipparion?*), sp., Owen, *Norwich Crag*, Norwich; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 223, fig. 130.

Equus plicidens?, Owen, *Red Crag*, Bawdsey, Suffolk; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 223, fig. 12.

Felis pardoides, Owen, *Red Crag*, Newbourn, Suffolk; Quart. Journ. Geol. Soc., vol. xii. p. 226, fig. 19.

? *Hyænodon*, Owen (carnivore allied to, and Pterodon), *Red Crag*, Woodbridge, Suffolk; Quart. Journ. Geol. Soc., vol. xii. p. 227, fig. 20.

Mastodon (Tetralophodon) Arvernensis, Falconer, *Crag*, Suffolk; Quart. Journ. Geol. Soc. (1857), vol. xiii. p. 331, pl. xii.

Megaceros Hibernicus, Owen, *Reg Crag*, Felixstow, Suffolk; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 226, fig. 18.

? *Microlestes*, Owen (small vertebræ), *Triassic?*, Frome, Somerset; Quart. Journ. Geol. Soc. (1860), vol. xvi. p. 493.

Phocæna, sp., Owen, *Red Crag*, Bawdsey, Suffolk; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 228, fig. 23.

Plagiaulax Becclesii, Falconer, *Purbeck*, Purbeck; Quart. Journ. Geol. Soc. (1857), vol. xiii. p. 278, fig. 1–14.

Plagiaulax minor, Falconer, *Purbeck*, Purbeck; Quart. Journ. Geol. Soc. (1857), vol. xiii. p. 281, fig. 15.

Pliolophus vulpiceps, Owen, *London Clay*, Harwich; Quart. Journ. Geol. Soc. (1858), vol. xiv. p. 54, pl. ii. iii. iv.

Prorastomus sirenoides, Owen, *Tertiary*, Jamaica; Quart. Journ. Geol. Soc. (1855), vol. xi. p. 541, pl. xv.

Rhinoceros hemitœchus, Falconer.

Rhinoceros Schleiermacheri?, Owen, *Red Crag*, Wolverton, Felixstow, and Sutton; Quart. Journ. Geol. Soc., vol. xii. p. 218, fig. 1–7.

Spalacotherum tricuspidens, Owen, *Purbeck*, Durdlestone Bay, Dorset; Quart. Journ. Geol. Soc. (1854), vol. x. p. 426, fig. 9–12.

Stereognathus ooliticus, Charlesworth, sp., *Great Oolite*, Stonesfield, described by Owen in Quart. Journ. Geol. Soc. (1857), vol. xiii. p. 1, pl. i.

Sus antiquus, Owen, *Red Crag*, Ramsholt, Suffolk; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 223, fig. 11.

Sus palæochærus, Owen, *Red Crag*, Sutton, Suffolk; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 223, fig. 10.

Tapirus priscus, Owen, *Red Crag*, Sutton, Suffolk; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 233, fig. viii. viii. *a*. ix.

Triconodon mordax, Owen, *Purbeck*, Durdlestone Bay, Dorset; 'Palæontology,' 2nd ed. p. 351.

Ziphius, Owen, *Red Crag*, Felixstow (*Dioplodon*, Gervais), Suffolk; Quart. Journ. Geol. Soc. (1856), vol. xii. p. 228, fig. 24.

It would be very desirable to make this list as complete as possible, and notices from our readers of any omissions would oblige.—S. J. Mackie.

Footprints in the Cambrian (?) Slates.—The readers of the 'Geologist' will no doubt remember the announcement by Mr. John Taylor, in the 'Geologist' for September, 1862, of his discovery of what he regarded as reptilian footprints in the Manx Cambrians at Dalby, near Peel, and the controversy to which that discovery gave rise. Without attempting to review that controversy in detail, I may say that while Mr. Taylor himself asserted the ichnolitical character of the imprints he discovered, in other quarters the most diverse opinions were expressed respecting them. Some thought that they might be specimens of some gigantic species of lingula; others denied their organic origin altogether, and regarded them as nodules, which are found occasionally occurring with a certain degree of regularity; others again, and these were by far the more numerous class, declined to express any decided opinion respecting them, the character and amount of the evidence produced by Mr. Taylor not being, in their judgment, such as would warrant the forming a definite opinion on a subject of such great difficulty. And so, with a general feeling that this discovery did possess a certain amount of palæontological value, and yet with a conviction equally general that it was almost impossible either to fix the amount of that value or make any practical use of it, this discovery of footprints in the Cambrian Slates of the Isle of Man has remained in abeyance for nearly a year, waiting till more satisfactory evidence should turn up in other quarters in the Isle of Man or elsewhere. This evidence I am now able to furnish, and that, too, in such abundance and of such a description, that I believe it is now quite possible to arrive at a perfectly satisfactory conclusion respecting the real nature and palæontological value of these much-disputed "footprints." Having recently come to reside at Laxey, and knowing that at several points along the neighbouring coast the rocks furnish the most decisive proofs of a shallow-water origin, I set myself to examine carefully these localities, in order to see whether they would furnish that further evidence which I believed necessary to the satisfactory settlement of the question respecting the nature of the supposed footprints. My search has at length proved eminently successful. One of these localities, Laxey Bay, yields these "footprints" in great abundance. This bay, one of great width but of inconsiderable depth, is backed throughout almost the whole of its extent by tall precipitous cliffs, rising out of the water at an extremely high angle to a height of from 80 to 200 feet. Some of these cliffs at the north end of the bay, and contiguous to the old village of Laxey, have been quarried for building purposes, but not to any great extent, and almost the whole of the picturesque scene remains in its natural condition, untouched by human hand, and overgrown with golden gorse and tufts of waving ferns.

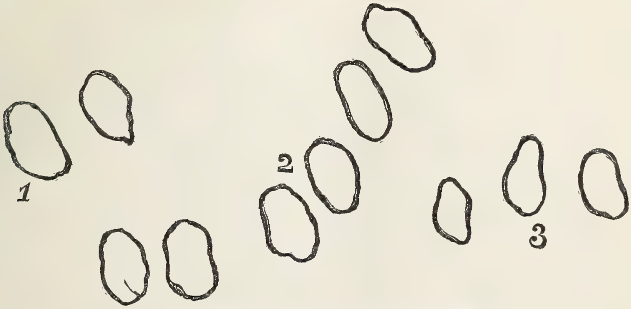
Starting from a point near the village, and proceeding in a south direction along the margin of the bay, we see the slates which compose the cliffs on our right, and the broken jagged rocks over which we scramble, covered with the most beautiful series of ripple-marks it has ever been our lot to see. Layer after layer, for hundreds of yards, as they crop out from below each other, is covered with these hieroglyphs of the past. And what adds considerably to their interest is, that the *pattern* of these ripplings is almost infinitely varied, scarcely any two surfaces being exactly alike in its markings. But these splendid ripple-marks are not all of interest that these slates contain. Studding the surface of the rocks, and among the ripplings I have alluded to, are *numberless* impressions of the same kind as those discovered by Mr. Taylor at Dalby. To what extent these impressions may be found, I am, as yet, unable to say. I have already traced them for a distance of about half a mile, throughout the whole of which they are found continuously both on the rock laid bare by the quarrymen, and also on the face of the untouched cliff.

In shape these impressions are of an irregular oval form, the breadth usually somewhat more than half the length. In size they are generally about nine or ten inches long by about five or six inches wide; but they are often found of not much more than half that size, and in several instances I have seen them of the enormous size of eighteen inches long by ten inches wide! I have presented to the Manchester Museum a slab containing an impression of this extraordinary size, which in the rock formed one of a group of three.

In substance they are generally somewhat softer than the rock in which they are enclosed, so much so, in fact, that it is no unusual thing among the rocks lying between high- and low-water mark, and hence, of course, subject to the direct action of the sea, to find slabs with the fossil footmarks, more or less washed out of the rock, and the matrix presenting the appearance of a deep water-worn hole. Above high-water mark they are strongly coloured with iron—a circumstance which enables the seeker to distinguish them with great facility, as they show with great distinctness upon the weathered light-grey face of the cliffs. Their faces also are usually thickly studded with pyrites and fragments of quartz, etc., of a rounded form: these are not merely coated over the surfaces of the impressions, but are in great part enclosed within their substance, so that when you pick out one of them with the point of your chisel, it leaves behind it a deep indentation. This accounts for the curiously pitted appearance of many of the impressions.

With respect to the order in which these imprints occur, I regret that I have not *now* the opportunity of entering into such minute particulars as should enable the readers of the 'Geologist' to judge of their nature for themselves. The distance over which these imprints are known to extend, and the fact that they are the footmarks not of one but of a great number of animals, while facilitating, from a personal inspection, our arrival at a satisfactory conclusion respecting their nature, greatly increase the difficulty of giving within anything like a reasonable space a clear idea of the order of their occurrence in this locality. In as few words as possible, however, I will try to indicate one or two of the more prominent features of this part of the subject, leaving a fuller detail for a future communication.

Occurring in great numbers and over a very considerable area, these impressions seem, at first sight, to be scattered over the face of the rocks without the least order or regularity; a more careful examination, however, reveals an amount of regularity in the order of their occurrence which not merely demonstrates satisfactorily their organic origin, but indicates to a great extent the nature of the animal that formed them. In pursuing this examination it is soon found that they most frequently occur in groups of one or more pairs, usually in a single group of two, Fig. 1; but also occasionally in a series of such groups, for example, as in Fig. 2, which is a reduced outline of a portion of one of the slabs I have inspected. Another frequent group is one of three impressions, arranged as in Fig. 3.



Impressions in the Cambrian (?) Slates.

In some instances the markings forming these groups are of the largest size yet discovered,—18 inches long by 10 inches broad. I am inclined to think, however, that this particular arrangement of the markings into a group of three is merely an example of a *double* group of two, the fourth impression being probably hidden by the overlying rock, or missing from some other cause.

Mr. Taylor, in his account of his discovery of similar fossil footprints at Dalby, considers them to have been formed by a tortoise-like chelonian, and founds his opinion partly upon the fact that the footmarks he discovered strongly resembled the Canadian *prolichnites* figured in Owen's 'Palæontology,' and which were, in the first instance, supposed to have been formed by a chelonian; and partly upon the fact, that upon the slab in his possession the impressions were "about 4 inches on each side of a straight line, alternately on this side and on that." This reference of these markings to a chelonian origin is not, I believe, borne out by later researches. Professor Owen (quoted by Murchison, 'Siluria,' first edition, page 205), in consequence of the discovery of better specimens, now refers them to crustaceans, an opinion confirmed by the discovery of similar crustacean markings by Professor Harkness in Roxburghshire in 1855. "These curious impressions are not at all unlike those for larger prints which Professor Owen has so well described, and which were found by Sir W. E. Logan in the Potsdam sandstone of Canada. In this case, however, it would appear that a single pair of legs successively produced the imprints (not four, or five, or more, as in the Canadian tracks), and they are most likely to have been made by an animal swimming with difficulty in very shallow water, such as Professor Harkness proves to have been the condition of the locality from physical evidence" ('Siluria,' page 168, edition 1859). From this it would appear that the original supposition that the "*Prolichnites*" were the tracks of chelonians, has not been borne out by more recent discoveries, but that they are now referred to a shrimp-like crustacean, analogous to the *Hymenocaris* of the Lingula flags. Further, with reference to their arrangement in single prints "alternately on each side of a straight line," as Mr. Taylor states them to occur upon the slab in his possession, throughout the whole of my examination of the markings at Laxey,—and I have examined hundreds of specimens,—I have not been able to identify distinctly any such arrangement. On numerous slabs, however, were I to cover up half the marked surface, the markings would assume an appearance very similar to that described by Mr. Taylor; and in this way, particularly as by his own account the exposed surface was very limited in extent, I should account for the appearances described by him.

But although I have not found these tracks occurring in the order described by Mr. Taylor, I have found them occurring in an order very similar to that described in the passage from the 'Siluria' quoted above. The arrangement most perceptible is *in groups of two*, and these groups are often found occurring in clusters, as would result from the "animal swimming with difficulty in very shallow water." That the water in this locality was very shallow we have abundant evidence. Hence I do not agree with Mr. Taylor in attributing these fossil footmarks to a chelonian, but, with the evidence at present before me, I am inclined to refer them to a crustacean.

In conclusion, I would respectfully submit to the scientific world the propriety of making a thorough investigation of this important discovery. The discovery of these tracks is an extremely rare occurrence, and their true nature is consequently proportionably mysterious to geologists; it follows therefore that their discovery in such remarkable abundance, and under such favourable conditions, is a fact of very considerable importance; and I trust that this announcement of their existence, necessarily brief and imperfect, will not pass unnoticed, and that the matter will receive a careful and thorough examination at the hands of competent men. If anything I can do will be of service in this inquiry, either by corresponding on the subject, by forwarding specimens, or by personally acting as guide over the locality, I shall be very glad to be of use.

I shall be obliged if you will insert the enclosed communication in your August number, as the summer is getting on, and I am anxious to attract some of the English geologists over to examine the tracks.—Yours sincerely, THOMAS GRINDLEY.

Laxey, Isle of Man, July 24th, 1863.

ANCIENT CANOE.—A remarkable discovery has been made by some workmen in draining the fields which were formerly covered by the waters of Giggleswick Tarn, Yorkshire. At the depth of some five feet they struck upon an ancient canoe, which an eminent antiquarian, who has examined it, has pronounced to be Celtic, and probably not less than two thousand years old. It has been hollowed out of the trunk of a huge tree, probably an oak, which must have been 4 or 5 feet in diameter at least. The canoe is 7 or 8 feet long, about 2 in breadth, and 2 in depth, with ends roughly and abruptly pointed. It is flat-bottomed, no doubt because the lake was shallow even in ancient times. Through one of the ends of the boat, which served as the stern, is a round hole, through which it is conjectured a pole was thrust, either to steer the boat by or paddle with. This hole was plugged up with a conical piece of wood. Not the least curious parts of the canoe are two wooden *wings*, 5 or 6 inches broad, which were fastened to the sides by round plugs of wood; perhaps they served to steady the boat. Two iron crooks, each about 18 inches long and fastened together by a ring of iron, were found near it, and look like a rude anchor. The whole thing looks as if it had been made with great care, but by a nation unacquainted with planes or sharp-cutting instruments; though that *some* uses of iron were known is shown by the anchor. The canoe is the property of W. Hartley, Esq., and it is much to be hoped that some good antiquarian will give us a more accurate account of it and its different parts.

ERRATA.—The name of the writer was omitted in the letter, pp. 248, 249. It was by Dr. Leslie. At page 242, *for* tab. "xxxii." *read* tab. "xxxii*."

MISCELLANEOUS NOTICES.

The 'Quarterly Review' of last month (July) has an exhaustive article on Dr. Tyndall's 'Glaciers of the Alps' (1860).

The fifth part of vol. iv. of the 'Tyneside Naturalists' Field Club,' contains the reports of the dredging expedition to the Dogger Bank and along the coasts of Northumberland, made under a grant from the British Association in 1861. There is an article on the "Geological Features of the Parish of Edmondbyers," by the Rev. W. Featherstonaugh, M.A. This point forms, for five miles, the north-west boundary of the county of Durham, and is mostly unenclosed moorland. The higher ranges of hills varying from 1000 to 1300 feet above the level of the sea, are composed of beds of sandstone of various qualities, forming part of the "Millstone Grit," the strata of which dip towards the south-east, and overlie, in descending order, beds of ironstone, limestone, and the metalliferous strata, which furnish the mineral wealth of the Derwent Heads and the Allenheads lead mines.

REVIEWS.

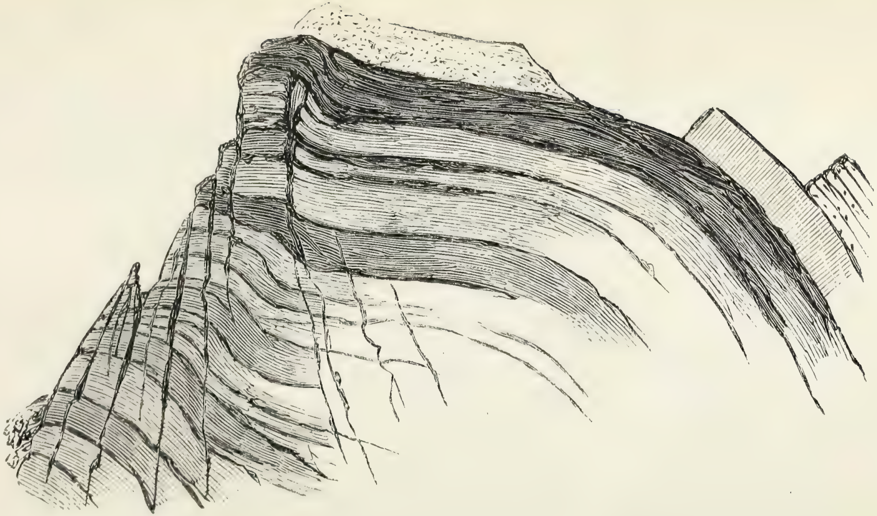
The Correlation of the Natural History Sciences.

By D. T. Ansted, M.A., F.R.S.

In this, the Rede lecture, delivered before the University of Cambridge on the 12th of May last, Professor Ansted points out some of the mutual relations that exist between the various departments of science, but especially the manner in which all natural sciences relate to geology, and geology to all the others. By comparisons of this kind, he justly observes, suggestions are obtained leading to fresh discovery, while they give precision to our knowledge, and serve not unfrequently to remind us of our ignorance. The lecture is clear and concise, and precisely displays how the advance of one science forces on improvements and modifications in another, and that progress cannot be effected in any without its effects being felt in all the rest, as well as amongst each other. A knowledge of the perfect circulation of water, for example, is a definite result of modern investigation, and is fruitful in geological suggestions. Present in the great ocean, and covering a part of the land, the quantity of fluid water on the globe is manifestly limited, in great measure, by temperature. And so the question touches on Meteorology. Were the earth cooled down below the freezing-point of water, though a certain portion of aqueous vapour would remain to form an atmosphere, the whole earth would be solid, and the circulation of water checked. Were the temperature to be raised above the boiling-point, the water would exist only as a vapour-atmosphere. In this case also its circulation would be arrested, and life would cease. In this way the subject might be extended to zoology, and on through chemistry, physical geography, and the whole circle of the sciences. At present geologists are apt to assume the internal igneous fluidity of the earth, and much useless speculation has been indulged in as to the thickness of its crust. Calculating from established observations, Professor W. Thomson considers that the solid substance of the earth must consist, on the whole, of solid material, more rigid than steel, because if it were not so, the actual height of the tides and the amounts of precession and nutation would be smaller than they are found experimentally to be. But the rigidity of the upper or surface-crust of the earth is less rigid than glass, and therefore the interior must be more rigid than steel,—a fact utterly at variance, Professor Ansted admits, with the hypothesis of the earth being a mass of molten matter enclosed in a hollow shell less than a hundred miles thick, open to volcanos and disturbed by earthquakes, whilst he considers it agrees with the calculation formerly made by Mr. Hopkins, from other data, that the crust cannot be less than 800 miles thick. Professor Thomson, however, concludes that no thickness of crust, less than half the earth's radius, could enable our planet to preserve its figure with sufficient rigidity to allow the tidal phenomena and the phenomena of nutation and precession to be as they are.

Again, the observations recently made by Professor Tyndall on the effect of vapour on solar heat-rays reflected back from the earth into the air, though not having apparently much to do with the rigidity of the earth, and strongly contrasting in the nature of the method employed, point to the same general conclusion, and afford another example of the correlation and of the intimate dependence of different departments of inquiry. It results from Professor Tyndall's experiments, that of the heat radiating from the earth in England, more than ten per cent. is stopped within a distance of ten feet from the surface. In proportion as the air contains more vapour it radiates less rapidly, and it would seem to follow that a uniform steam-temperature of the earth's surface must so completely intercept the solar heat-rays as to render the earth unfit for any kind of life, animal or vegetable, with which we are acquainted. In other words, the balance of heat received from the sun must probably have existed at all times nearly as it does now, to allow of such organic life as we know of. A very much higher temperature, Professor Ansted thinks, would, by disturbing this equilibrium, unfit the earth for the existence of races so nearly resembling those now living upon it as are indicated by even the oldest fossil remains. Mr. Glaisher's balloon experiments confirm Professor Tyndall's deductions as to the state of the atmosphere in the higher regions, and so unexpectedly these two seemingly unconnected meteorological experiments come in as evidence. It is in this manner that Mr. Ansted brings forward the most interesting facts in the modern progress of the sciences, to show their relationships to geology and to one another, and the influence of the advance of geology upon them. Agreeably and logically framed, Mr. Ansted's discourse will afford half an hour's intellectual gratification of an instructive and highly suggestive character.

PLATE XVII.



IDEAL SECTION OF LA SALEVE, FROM A DIAGRAM BY JOHN RUSKIN, ESQ., F.G.S.

S. J. Mackie del.

THE GEOLOGIST.

SEPTEMBER 1863.

MR. RUSKIN'S LECTURE ON THE SAVOY ALPS.

By the Editor.

Of Mr. Ruskin's admirable lecture on the Alps of Savoy, delivered at the Royal Institution, we have already given an abstract at p. 256. We recur again to that subject because there were two points so forcibly and so well put by Mr. Ruskin, and so seemingly pregnant with the germs of future progress to our science, as to merit the special attention of geologists. These were the inefficacy of ice to scoop out lake-basins, and the mighty wave-like action of force that crumbles the gigantic rock-masses of our mountains almost into wave-like breakers ready to nod and fall. "Geology," well remarked Mr. Ruskin in his opening words, "properly divides itself into two branches,—the study, first, of the materials and chronology of deposits; and, secondly, of their present forms." The interest attaching to the relics of organic life, without doubt, has carried geologists away from the study of external forms; and this almost exclusion of regard for structural phenomena is the more to be regretted that it is the threshold of the grand field of record of ancient physical phenomena. The gigantic mountain-wave is not heaved up and rolled onwards in a few moments, like the surging waves of the sea; the particles of rock-masses are not quickly moved about like the water-atoms of the dancing ripples on our rivers, but slowly—slowly indeed—are the almost immovably linked-together particles forced onwards by some ponderous pressure, some solemn but irresistible force, due perhaps to the very strain of the earth's altering rotation or the leverage of its surface inequalities upon its central axis. Into these questions Mr. Ruskin did not enter; he found enough, and more than enough, to do in his first essay to get the answer out of the easiest riddle he could find. No one can look at a piece of marble and not see the records of particle-changes in solid rocks. The stratum of sea-mud, once without a flaw, has been hardened, dried, cracked into innumerable fragments, and these are now soldered together by crystalline spar. Well, indeed, did Mr. Ruskin select the beautiful marble as an example of particle-movements in rocks. Nor let it be thought that the crystallizing action is confined to the open cracks; it goes through the very body of the stone: marble, black, white, grey, or variegated, is crystalline throughout. The sea-mud, which it was originally, did not fall on the ocean-bottom in crystals, nor did it dry up, like the salt of the sea, in crystalline forms. But it consolidated into a hard amorphous rock, and then the crystalline forces moved particle after particle, and put it into regular form. "So that," said Mr. Ruskin, in his eloquent language, "through the whole body of the mountain there runs, from moment to moment, year to year, age to age, a power which, as it were, makes its flesh to creep; which draws it together into narrower limits, and in the drawing, in the very act, supplies to every fissure its film, and to every pore its crystal." And in this change the imaginative mind of Mr. Ruskin saw, perhaps with prophetic distinctness, how all terrestrial things were purifying themselves for some greater end, some more beautiful condition. "All is advance," he said, "from disorder to system, from infection to purity; nor can any of us know at what point this ascent will cease. We can already trace the transformation from a grey flaky dust, which a rain-shower washes into black pollution, to a rock whose substance is of crystal, and which is starred with nests of beryl and sapphire. But we do not know if that change is yet arrested, even in its apparently final results. We know in its earlier stages it is yet in progress; but have we in any case seen its end?"

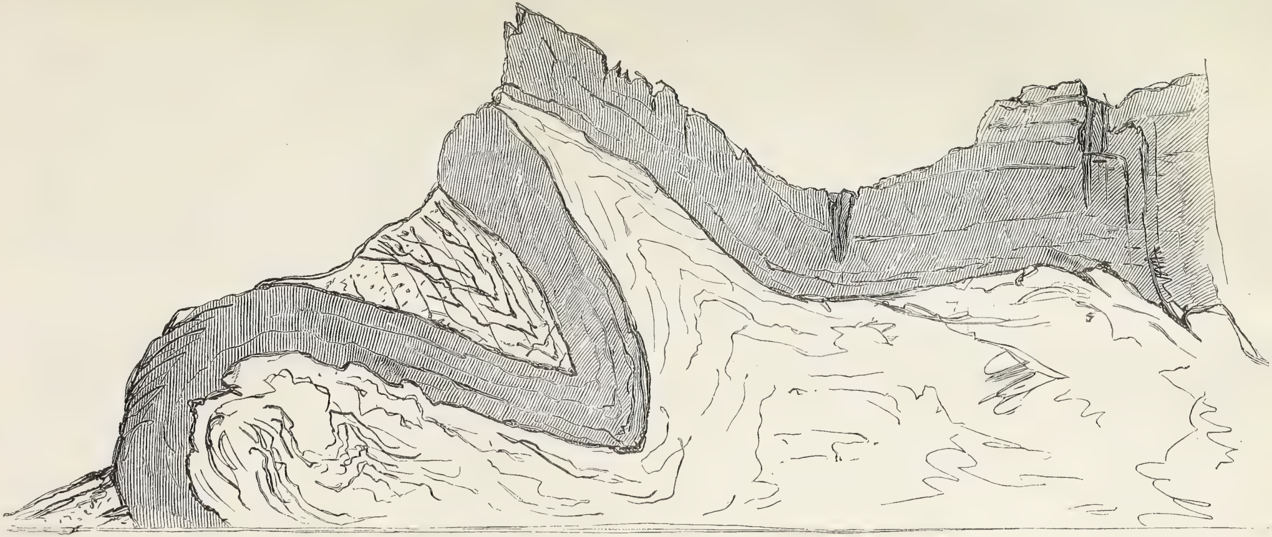
But not only is there a gathering together of circumambient particles round crystalline axes, but the very body of the rocks, over miles and miles of ground, are capable of onward surging motions, like the long rolling of heavy waves,—the very rocks that form those mountains which, to us, are the types of solidity and endurance. The "everlasting" mountains, as they seem to us, are to Mr. Ruskin's eye as viscous as the glacier ice; traversed by innumerable fissures permeating play and motion, sometimes filled with water, sometimes with vapour, with gelatinous flint, with metal-ore. We may have a crag-glacier, measurable in depth by miles instead of fathoms, stiffened with bands of agate and flexible with fibres of iron; *flexible, at all events, by its own molecular or fragmentary division*, and assuming new dimensions or flowing into new channels through gradations which are immeasurable, and in times of which human life—we might almost say human history—forms no appreciable unit. Having dealt with the substance of the mountain, Mr. Ruskin goes on to the formation. Taking its collective rock-strata as so many original sea-bottoms level and flat, he seeks to find out how the Alpine mountain assumed its present rugged, dislocated form. We do not say Alpine mountains, for such mighty monuments are not to be read at once; no eagle eye could read these wonders at a glance, with secrets hidden by fallen débris, and records buried and wrapped up in the folds and bends of a gigantic earth-mantle. Mr. Ruskin found a portion and a corner of the magnificent Alps of Savoy sufficient to task his skill and knowledge. "There are," said he, "the mountain which is cut by streams or by more violent forces out of a mass of elevated land, just as you cut a pattern in thick velvet or cloth; and there is the mountain produced by the wrinkling or folding of the land itself, as the more picturesque masses of drapery are produced by its folds. Be clear in separating these two conditions."

It is something wonderful to think of such slow but perfect plasticity in rock,—to see, in the mind's eye, particle pushing particle, and particle after particle yielding to the pressure through ages that man's race cannot count, lifting, rising, surging so slowly and solemnly, that no eye can perceive the motion, no ear detect the slightest grating in its onward rush; for rush it is, although so slow and silent. "There are," Mr. Ruskin continued, "two ways in which this folding of the hills may be effected. You may have folds suspended or folds compressed. If underneath, a mass comes up which sustains the folds,—a pendant wave; but if the force be lateral, you have a compressed wave. And observe this further distinction:—if a portion be raised by a force from beneath, unless the beds be as tenacious as they are ductile, they will be simply torn up and dragged out of shape at that place, and on each side the country will be undisturbed. But if they are pushed laterally into shape, the force of the thrust must be communicated through them to beds beyond; nay, the rock which immediately receives the shock may, if harder than those beyond it, show little alteration of form, but pass on the force to weaker beds at its side, and thus affect a much larger space of country than the elevatory convulsion. Now the fact is that in the Alps both these actions have taken place, and have taken place repeatedly, so that you have evidence both of enormous lateral thrusts which have affected the country for hundreds of miles, and of local elevations independently operating through them, and breaking their continuity of action. . . . The ripple of a streamlet rises, glances, sighs, and is gone. An Atlantic wave advances with the slow threatening of a cloud, and breaks with the prolonged murmur of its thunder. Imagine that substance to be not of water, but of ductile rock, and to nod towards its fall over a thousand vertical fathoms instead of one, and you will see that we cannot assert, perhaps cannot conceive, with what slowness of march or of decline the mountain-wave may rise or rest. But whatever the slowness of process, the analogy of action is the same. Only remember that this has taken place through rocks of every various degree of consistence and elasticity, and as the force thrills and swells from crag to crag, it is itself rent again and again into variously recoiling, quenched, or contracted energy, and divides against itself with destructive contradiction."

Two examples of this gigantic-wave action were taken by Mr. Ruskin for analysis,—Mont Brezon and Mont Saleve,—the former "notable in the clash and curve;" but as he knew it was full of almost incredible structures, he selected the latter to begin with as a most simple example, which had been already described by De Saussure, Studes, and Favre, from whose observations however Mr. Ruskin differs, and finds this simple mountain not so simple after all. These three geologists, leading or copying each other perhaps, as geologists very often do, represent the face of the hill towards Geneva to be formed by vertical beds; but Mr. Ruskin's impression is "that these perpendicular plates of crag, clear and conspicuous though they are, are entirely owing to cleavage,—that is to say, to the splitting of the rock in consequence of the pressure undergone in its elevation; and that the true beds curve into the body of the hill" (see Plate XVI.). "I dare not," he adds, "speak with any confidence in opposition to these great geologists, but I earnestly invite some renewed attention to the question, which is of no small importance in determining the nature of the shock which raised the walls of the Alp round the valley of Geneva." The ideal view of this mountain, which we give in Plate XVI., is from the diagram exhibited by Mr. Ruskin at the Royal Institution lecture, at which we were present, and from notes of which the present account of his views is given. It is but right to make this statement, as Mr. Ruskin is fully aware and feels the difficulties which at present attend the verification of these sections both of La Saleve and the Brezon. All the lower part of the Saleve is Jura limestone, as determined by Favre, and that this rises up in a nearly vertical sheet along the whole front, thrusting up the Neocomian and compressing it, Mr. Ruskin admits; "but there is doubt," he contends, "respecting these frontal clefts." Neither does he deny that there are raised beds of Neocomian on parts of the mountain, as assigned by Favre; but that at the Grande Gorge, where the natural section is clearest, there are the beds all following the curve of the summit, and that the vertical fissures are rather faults or cleavages, or partly both, the business being so complicated that one cannot tell which is which. Baffled by the simpler Saleve, Mr. Ruskin had little hope of resolving thoroughly the infinitely more complex Brezon; but on one or two points of it he gave very able expositions. And here again we take the liberty of copying another of his diagrams. "You see," he said in his lecture, "the group is composed of an isolated pyramidal mass, of a flat mass behind it" (see Plate XVII.), "which extends at both sides, and lastly, of a distant range of snowy summits, in which Mont Vergi and the Aiguille de Salouvre are conspicuous objects. Now these three masses are merely three parallel ridges of limestone-wave, formed mainly of originally horizontal beds of Rudisten kalk, approaching you as you stand looking from the Saleve. Probably, I think, approaching at this moment, driven towards you by the force of the central Alps, the highest ridge broken into jags as it advances, which form the separate summits of Alpine fury and foam; the intermediate one joining both with a long flat swing and trough of sea, and the last, the Brezon, literally and truly breaking over and throwing its summit forward as if to fall upon the shore. There is the section of it" (Plate XVII.); "the height from base to summit is 4000 English feet,—the main mass of the façade, formed of vast sheets of Rudisten kalk, 1000 feet thick,—plunging at last, as you see, in a rounded sweep to the plain." Nor is this instance an extraordinary one in anything but its simplicity and decision; the Brezon and Vergi group are only a portion of the longitudinal waves which flow parallel with the Alps through all their length, and which are cut across by transverse valleys, in which are the grandest scenes of Alpine precipice.

In treating of the sculpturing of mountains, or the working out of their actual forms, Mr. Ruskin laid the greatest stress on disintegration aided by chemical action, or by water acting as rain-torrent; and, although not ignoring the action of ice, dwelt properly and rightly on the view that ice was a less powerful agent than water in its other forms in a sculpturing capacity. In respect to the origin by glacier-excavation of the basins of the Swiss and other mountain-lakes, which Professor Ramsay claims to have suggested, we were very glad to hear Mr. Ruskin speaking out forcibly and to such good purpose. And it would be well indeed if, on some other so-called accepted topics, we had other keen thinkers speaking out as boldly and as eloquently as Mr. Ruskin has done on this.

After dwelling on the viscosity of glacier-ice, as shown by Forbes and admitted by Hopkins, Tyndall, and others, and generally everywhere now, and on those experiments which have shown the central portions of the glacier to be in quicker motion than the sides, which cling to the mountain or gorge on either hand, Mr. Ruskin charged the glacier motion as being wholly powerless wherever the glacier falls into a pit. "There have been," said he, "suggestions made that the glaciers of the Alps may have scooped out the lake of Geneva. You might as well think they had scooped out the sea. Once let a glacier meet with a hollow and it sinks into it, and becomes practically stagnant there, and can no more deepen or modify its receptacle than a custard can a pie-dish." And then he went on to show, as an example, how the great glacier of the Rhone could not cut a passage through the gorge of St. Maurice. That is indeed the true way to test: take a small obstruction, and see how a big glacier can deal with it. If it fail to remove *it*, how can it remove greater obstacles under less advantageous conditions, which it would have to do in scooping a lake-basin? Moreover, as Mr. Ruskin well put the facts forward, the glacier carries the fallen stones constituting its moraine on its surface, but does not produce the moraine by its own action. The glacier likes, so to speak, nothing under it; it glides forward on a launching smooth sheet; the moraine consists of the sheddings of the rocks above, not of the broken fragments of the ground beneath. The glacier, too, moves slowly; the torrent quickly, pushing stones, sand, and grit in its furious course, and grinding like a rough file moved at the rate of ten miles an hour. "The torrent cuts," says Mr. Ruskin, "the glacier cleanses; one is for incision, the other for ablution and removal; and so far as the present



SECTION OF THE BREZON, IN THE ALPS OF SAVOY.

From a Diagram by John Ruskin, Esq., F.G.S.

S. J. Mackie del.

form is concerned, you may ignore the glacier altogether. It only helps the torrent here and there by exposing a surface and by carrying off the rubbish which the working water throws down; but the two sculptors are natural disintegration and the stream, and every existing form in the Alps is distinctly traceable to one or other of these forces combined with the internal geological structure."

ON *ECHINOTHURIA FLORIS*, A NEW AND ANOMALOUS ECHINODERM FROM THE CHALK OF KENT.

By S. P. Woodward, F.G.S.

The fossils represented in the accompanying Plate are probably only fragments of the original structure, and possibly only the smaller and less essential portions of the whole. Nevertheless I have determined to publish some account of them, although at the risk of committing an extravagant error, as a last resort towards obtaining more complete examples or suggestions for their more correct interpretation.

Both specimens have been presented to the British Museum; one by J. Wickham Flower, Esq., of Park Hill, Croydon, the other by the Rev. Norman Glass, of London.

The first example (Fig. A) was obtained, at least sixteen years ago, from the Upper Chalk of Higham, near Rochester, and was submitted to Prof. E. Forbes, in whose custody it remained for several years. It was originally shown to me in connection with the anomalous Cirripede *Loricula*, then newly discovered by Mr. Wetherell. The resemblance between them is certainly curious; but there is no real relationship. Mr. Flower's fossil exhibits distinct traces of the crystalline structure peculiar to the petrified Echinodermata, and the pairs of pores in the ambulacral plates are equally characteristic of the Echinidæ. Mr. Darwin also has examined this fossil and rejected it from his province of inquiry.

Prof. Forbes could not make up his mind to describe the specimen, and ultimately it was returned to Mr. Flower, with whom it remained until the publication of a note on the genus *Proto-echinus*, by Major Thomas Austin, in the 'Geologist' for 1860 (Vol. III. p. 446), when it was entrusted to me for the purpose of considering whether it had any special affinity with this new type, and for description in the same journal.

The *Proto-echinus* was obtained from the Carboniferous limestone of Hook Head, Wexford, and is but a fragment of a single ambulacrum, consisting of three series of plates at the wider end and two at the other extremity, with apparently a single terminal plate. Each plate is perforated by a pair of pores. It differs from Echinothuria in every particular.

The question presented to me by Mr. Flower's fossil was, whether to consider it part of the envelope of a new kind of Holothuria or whether it might be no more than a fragment of the oral disk of some great unknown Echinus. Portions of the imbricating scaly armour of a Psolus had been met with when examining the fossils of the boulder clay collected by Mr. J. Richmond, of Rothsay; but in Psolus, while the greater part of the body is clothed with fish-like scales, the ambulacra are only developed on one side, forming a creeping disk, the scales of which are small and not imbricated. On the other hand, the peristome of the largest known Echinite from the Chalk is less than an inch in diameter; and the largest recent sea-urchin in the museum has an oral disk not more than 2 inches wide, whereas the fossil is a segment of a disk which must have been at least 4 inches across. This objection, on the score of size, was however less felt, because the Cyphosomas and Diademas of the Chalk have larger oral and apical orifices than any other urchins, and the character of their apical disk was unknown, being only preserved in a few minute specimens of *C. difficile*, from Chute Farm. Moreover, there were indications in the Upper Chalk of a great Diadema, of which nothing more had been obtained than scattered plates and fragments of spines. This species is referred to in Decade V. of the Geological Survey (Article Diadema, Section C, spines tubular, annulated). Mr. Wetherell obtained a mass of chalk containing above one hundred fragments of spines, which are hollow, striated and annulated, as in the recent *D. calamaria*. From the plates mingled with the spines we ascertained that the ambulacral pores presented the usual characters, being arranged in single file, and a little crowded near the peristome; but many of the plates presented only their smooth inner surfaces. A smaller mass of chalk, in Mr. Wiltshire's cabinet, contains similar plates and spines, mingled with a few true scales and minute truncated spines like those of Echinothuria. The Diadema spines were erroneously referred by Prof. E. Forbes to the genus Micraster (decade iii. pl. 10, fig. 15; bad, for they are not spiral). They are also figured by Dixon, in his 'Geology of Sussex,' and described by Forbes as "spines of a Cidaris." Diademas possessing spines of this character are known to occur in the Upper Cretaceous strata of France; and Dr. Wright has lately obtained a small specimen from the chloritic marls of Dorsetshire. In these the apical disk is quite small.

A more serious difficulty, in comparing Mr. Flower's fossil with the oral disk of any Echinite, was presented by the arrangement of the plates; in the recent Echinidæ (like the Cidaris represented by Fig. E) they are all directed towards the dental orifice, but here the alternate series take opposite "dips," the ambulacral plates overlapping one way and the others in a contrary direction.

Last year, while I was still hesitating about the publication of Mr. Flower's fossil, a second specimen was obtained from Charlton, in Kent, by the Rev. N. Glass, who has cleared it from the matrix with great skill and patience. It is represented by the figure marked D, and contains the dental apparatus, or "lantern," and portions of several series of imbricating plates radiating from it. At first sight, this specimen would seem to solve the problem, by supplying the peristome and lantern of the same great Cyphosoma or Diadema, of which Mr. Flower's specimen might be the apex or periproct. But a closer examination confirms the objections already stated, and gives increasing probability to the other conjecture (if, indeed, it does not compel us to adopt it), however difficult it may be to realize the notion of an Echinite having no proper "test," and clothed entirely with imbricating scales like those of the peristome of Cidaris.

In Mr. Flower's specimen (A) the imperforate plates imbricate towards the centre (or apex, *a*), where the smaller ends of the several series converge. In Mr. Glass's specimen they slope away from the centre (or mouth), that is, also towards the apex. The perforated or ambulacral plates, which overlap one another outwardly (*i. e.* downwards) in specimen A, are seen in B sloping towards the dental cone, and reclining upon it. The portion of an ambulacrum situated between the letters *a*, *b*, *c* (in B), consists of seven plates, diminishing in size from *c* to *a*, in a line not accurately directed towards the centre. This portion exhibits the *interior* surface of the plates, known by their curved surfaces, destitute of ornamental granules; it is not, however, the oral end of one of the segments turned over, a thing scarcely possible to happen, for in that case the dip of the plates would be reversed, but it must be the opposite (or apical) extremity of a series folded back upon its origin, and exposed to view by the damage which the surface of the specimen has sustained. From this circumstance it seems probable that the whole fossil, when complete, was not elongated nor even spherical, but somewhat depressed in a vertical direction, though doubtless admitting of a moderate amount of flexure. At the last hour, after making the drawing, I ventured to clear away the chalk from the side of Mr. Glass's fossil (near the letter *i*), where an ambulacral segment is seen to curve as if it might be continued round to the other surface. This attempt was successful, for the ambulacrum and also the adjacent interambulacral segment (*h*) were found continuous, though crowded and displaced at the turning, falling again into regular order, and diminishing in size, though not so nearly complete as in Mr. Flower's example.

After this apparently conclusive demonstration, it appears desirable to give a name to the fossil, and to attempt a short description, although its rank and affinities are to us still matter of conjecture. At present it is one of those anomalous organizations which Milne-Edwards compares to solitary stars, belonging to no constellation in particular. The disciples of Von Baer may regard it as a "generalized form" of Echinoderm, coming, however, rather late in the geological day. The publication of it should be acceptable to those who base their hopes on the "imperfection of the geological record," as it seems to indicate the former existence of a family or tribe of creatures whose full history must ever remain unknown.

Order *Echinidæ*. Genus *Echinothuria*.*

E. floris, n. sp.; *test* globular?, diameter of compressed specimen 4 inches, thickness ½ an inch, lantern projecting ½ an inch; composed of ten segments or double series of imbricating plates, ornamented with obscure miliary granules and small spine-bearing tubercles, a few larger than the rest; *interambulacral* plates narrow, slightly curved, with the convex edge upwards and overlapping; the alternate plates bearing one large extero-lateral tubercle, perforated, and surrounded by a raised ring and smooth areola; largest plates measuring 6 lines in length, the smallest 3 lines or less (the longest in second specimen equalling 7 lines); *ambulacral* plates 7 lines long, equalling the breadth of the exposed portion of eight plates, similar to the former, but curving and imbricating downwards towards the dental orifice, and having two small plates, each perforated by a pair of pores, intercalated in a notch of the middle of the lower margin; a third pair of pores perforating the plate itself a little external to the centre; primary tubercles few, irregularly distributed.

Spines of three kinds; those adhering to the plates minute and striated; fragments of larger spines (not certainly belonging to the species), striated, annulated, and furnished with a prominent collar to the articular end (Fig. C); the third kind minute, clavate and truncate, articulated (?) to a slender stalk (Fig. E *d*).

Explanation of Plate.

Fig. A. Mr. Flower's fossil; *a*, centre of upper surface; *b*, an interambulacral segment; *c*, ambulacrum; *d*, lateral half of a second interambulacrum.

Fig. B. Mr. Glass's specimen; *o*, dental apparatus; *a*, inner surface of apical portion of an ambulacrum; *c, e, g, i, l*, position of the five ambulacral segments; *b, d, f, h, k*, position of five interambulacral segments, of which only fragments remain; *d, k*, position of small clavate spines.

Fig. C. Three ambulacral plates near the summit, showing to what extent their outer ends are overlapped by the interambulacral plates.

Fig. D. One of the larger spine-fragments, natural size and magnified.

Fig. E. Oral disk and teeth of a recent Cidaris; *a*, the five ambulacral segments with notched and perforated plates.

CORRESPONDENCE.

Foraminifera of the Chalk.

Sir,—I was much pleased, in looking over your "Thoughts on Dover Cliffs," by meeting with the Foraminifera figured in Plate I. representing so many forms; also with the notes of the figured specimens by Professor

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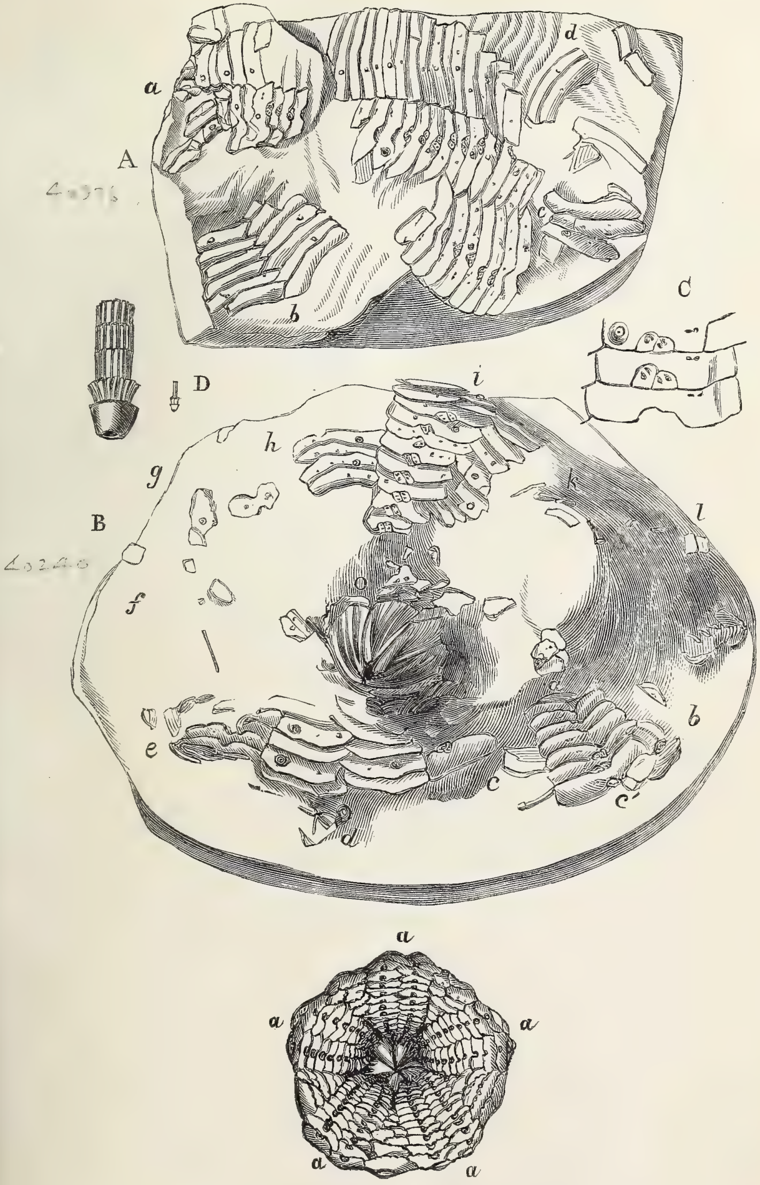
* Etymologists need not trouble themselves about the derivation of this name; it is intended merely to express the dilemma in the writer's mind, arising from imperfect knowledge, but which he believes to have no foundation in nature.



ECHINOTHURIA FLORIS (New Species).

From the Chalk of Kent.

S. P. Woodward, F.G.S., del.

Rupert Jones, F.G.S., obligingly given you. I ask, would you have the kindness to give me a simple method of treating chalk so as to procure these microscopic creatures, whose carcases build up so many thousand miles of solid chalk rock?

Yours truly,
R. M. F.

[To prepare chalk for microscopic examination, if only small quantities are to be treated, the best plan is to select a piece of soft white chalk,—that which has been kept some time in a cabinet is most easily worked,—especially chalk from the interior of an Ananchyte or Galerite, and to wash it with a moderately soft nail-brush in a hand-basin half full of water, keeping the chalk and brush under the surface, so that the loosened particles should all fall in the water. To prevent the chalk from being worn into longitudinal furrows, the part under the brush should be constantly moved round. It should also be looked at occasionally, with a hand magnifier, so that any large specimens of Bryozoa and Foraminifera may not be destroyed by rough brushing, but be more carefully picked out with a needle or penknife, or separated by the careful use of the brush. When a sufficient quantity has been brushed down, the water should be stirred and the chalky portion poured away, or water should be allowed to run into and overflow the basin, until the water remains clear over the sediment. The latter should then be placed in a round-bottomed cup or gallipot, and rubbed gently with the finger in water, until, by further washing, some more of the chalk has been removed, when the residue should be carefully dried in an oven or otherwise, without the least disturbance. When dry, it may be sifted and picked, but if it be still "chalky," further manipulation by gentle rubbing in water will be necessary, especially if the chalk-dust has been put by for some time after having been prepared. On a large scale, chalk may be prepared by being broken up in a mortar, or roughly ground with a brick, stone, or roller, on a pavement, and then freely washed in water, the large fragments being excepted.

The above, and other instructions for "the preparation of clays, sands, and chalk for microscopic purposes," were given in the first volume of the 'Geologist,' 1858, p. 248, by Mr. Rupert Jones; and in the same paper, a sieve, with a double cylinder, and fitted with different zinc perforated plates, was described and figured. Such sieves can be had of Mr. Snow, zinc-worker, 50, Millbank Street, Westminster, at the cost of about 3*s*.]

NOTES AND QUERIES.

Discovery of another Cave at Uphill.—Sir,—It may be interesting to your readers to learn that another cave has lately been opened at Uphill. Its entrance is on the south side of the rock, at an elevation of about sixty feet from the base. Besides the usual stalagmitic breccia, common to the caves of the Mendips, this is partially filled with an unctuous loam, which is exceedingly rich in animal remains. I have obtained bones of the wolf, fox, wild-boar, otter, and also the horns of a stag; and, which adds not a little to the interest of the discovery, several human remains associated with them—amongst others, a thigh bone, part of a frontal bone, and portions of the upper jaw with the teeth *in situ*, of a human adult. I have been informed several crania have been exhumed, but in consequence of there being no local museum in which to deposit them, they have been removed to Oxford. As yet no trace of any extinct animal has been met with; but should such hereafter be found, the problem of the antiquity of man will meet an unexpected solution. I believe the merit of the discovery of this cave is due to Mr. Parker, of Oxford, at whose expense the workmen are employed in exploring it.

I remain, Sir, your obedient servant,
Charles Pooley.

Weston-super-Mare, August 25, 1863.

A CLASSIFIED AND STRATIGRAPHICAL LIST OF FOSSIL MAMMALIA. By S. J. Mackie, F.G.S.

+ European area. † N. American. o S. American. * African. ‡ Asiatic. § Australasian.

Species.	Alluvial.	Diluvial.	Caverns.	Pleistocene.	Pliocene.	Miocene.	Eocene.	Cretaceous.	Oolitic.	Localities, Authorities, and References.
I. CARNIVORA.										
1. Ursidæ.										
Ursus sp.			×							*Caverns*, Krapacks mountains (= Dragons fossiles), J. P. Hayn, Eph. Nat. Cur. Déc. 1, 1672; Ann. iii. p. 220, Obs. 139, p. 257, and Obs. 194, p. 166.
——			?							—— ? (= Licornes fossiles, and Os de dragons), Transylvania, Wolgnad, *op. cit.* 1673, p. 214.
——			×							*Caverns*, Hungary, Brückmann (= bones of bears) (1732), Descrip. des Cavernes de Hongrie, Coll. de Breslau, 1r tom. p. 628; and Sammlung von Nat. et Med. Acad. Nat. Cur. in Breslau (1725), s. 509, Relat. xv. xxiv. s. 628.
——			×							*Caverns*, Camper, Matér. pour l'Histoire et la Conn. des Foss. 1795, 1r cahier.
——			×							*Caverns*, Rosenmüller, Abbildungen und Besch. der fossilen Knochen der Höhlen-Baeren, 1804.
—— (9 species ?)			×							*Caverns*, Franconia, Esper (1774), Descrip. des Zoolithes, tab. i. to xiv. (Gailenreuth and Bayreuth.)
——										Blumenbach.
——										Cuvier.
——										Wagner.
—— ?										*Pleistocene*, gravel and marl, Folkestone, Mackie, the specimen in Folkestone Museum.
—— ?						?				*Miocene;* (?) Sansan, Archiv für Naturgeschichte, 1843, t. 1, p. 24. Pictet, p. 186.
—— spelæus		×	×							*Caverns*, England, France, Belgium, Germany, etc. = Ours des Cavernes, and Ours à front bombé, Cuvier, Ossem. Foss., 4th edit. t. vii. pp. 243 and 252; = *Ursus spelæus*, Blumenbach; Schmerling, Ossem. Foss. des Cavernes de Liége; De Blainville, Ostéographie, p. 53; Wagner, Archiv für Naturgeschichte; Owen, Brit. Foss. Mammal. p. 86; Giebel, Fauna der Vorwelt, t. i. p. 67; Gervais, Zool. et Pal. Fr. p. 105; Juliet, Comptes Rendus de l'Acad. des Sc. (Sept.) 1835; Hörnes, Cavernes de Brünn (Wiener Mitth. 1848, t. iv. p. 176); Giebel, Caverne de Sundwich (in Leonh. and Bronn's Neues Jahrbuch, 1849, p. 61); *Loess*, Odessa, Nordmann, Ossem. Foss. trouvés à Odessa, p. 4; *Loess*, Brisgau, Gegenbach, Verh. Basel Nat. Gesellsch., 1838–40, p. 81; *Cavern*, Gaylenreuth; Pictet, Paléontologie, p. 187; Atlas, pl. 2, f. 1–3; (= *Ursus arctoideus*, Blum. = *Ursus planus*, Oken, = Ours à crâne moins bombé, Cuvier, = females of *U. spelæus*, Blainville;) Pictet, Paléont. p. 188; *Cavern* of Baumann and Scharzfelder in the Hartz mountains, Leibnitz, Opera, Genev. cura Schneidii, t. ii. s. 34, p. 229; Sömmering, in Grossens Magazin für die Naturgeschichte der Menschen, 3 band, 1 stück, n. 3; *Caverns* of Mockas and Klunstein in Zahnloch, and near Waischenfald, Bavaria, Rosenmüller, Ab. und Besch. der foss. Knoch. der Höhl.-Baeren, 1804, p. 5; *Cavern* of Liebenstein, in the Duchy of Meiningen, Zach, Monatliche Correspondenz zur Beförderung der Erd- und Himmelskunde, 1800, p. 8.

Ursus spelæus, *var.* Pittorii									*Caverns*, Mialet and Nebriach, caverns of Cevennes and Lozère, Marcel de Serres, Bulletin des Sc. Nat. et de Géologie (Jan.), 1830, p. 511; Pictet, Paléontologie, p. 188; Blainville, Ostéog. p. 65.
—— spelæus, *var.* metopoleianus									—— ?, —— ?, Marcel de Serres, Annales des Sc. d'Observation (Feb.) 1830, p. 229; Pictet, Paléont. p. 88.
—— spelæus, *var.* metoposcairnus									—— ?, —— ?, Marcel de Serres, *op. cit.* p. 229; Pictet, Paléont. p. 198.
—— spelæus (= planus			×						*Caverns*, *loc. cit.* Oken.
—— spelæus (= spel. *fem.*			×						*Caverns*, *loc. cit.* Blainville.
—— spelæus, *var.* Neschersensis			?						—— ?, Neschers, near Clermont-Ferrand, Croizet and Jobert, Recher. sur les Oss. Foss. du Puy-de-Dôme ?; Blainville, Ostéog. p. 69.
—— spelæus, *var.* dentifricius			?						—— ?, H. v. Meyer, in Leonh. and Bronn, Neues Jahrb. 1839, p. 78.
—— spelæus, *var.* fornicatus (major and minor)			×						*Caverns*, Liége, Schmerling, Ossem. Foss. des Cavernes de Liége, p. 105.
—— spelæus, *var.* giganteus			×						*Caverns*, Liége, Schmerling, *op. cit.* p. 113.
—— priscus (= Ursus arctos)	×	×	×						*Caverns*, Gaylenreuth, Goldfuss, Nova Act. Acad. Nat. Cur. t. x. 2, p. 259; Cuvier, Ossem. Foss. 4th edit. t. vii. p. 265; Liége, Schmerling, *op. cit.* p. 87; Kent's Hole, Torquay, Owen, Brit. Foss. Mam. p. 82; S. of France, Gervais, Zool. et Pal. Franç. p. 107; Pictet, Paléont. p. 189; Atlas, pl. 2, f. 4–6. Owen, etc.
—— arctoideus			×						*Caverns*, England, France, Belgium, Germany, etc., Blumenbach; Cuvier, Ossem. Foss. 4th edit. t. vii. p. 162.
—— arctoideus, *var.* Leodiensis			×						*Caverns*, Liége, Schmerling, *op. cit.* p. 106; Pictet, Paléont. p. 188.
—— Arvernensis					×				*Pliocene*, Montagne de Perrier, Croizet and Jobert, Recher. sur les Oss. Foss. du Puy-de-Dôme, vol. i. p. 188, pl. 3, fig. 4.
—— Arv. (= *U. minimus*)				?					*Pleistocene ?*, Montagne de Boulade, Devèze and Bouillet, (= alluvial) Mont. de Boulade, p. 75, pl. 13, fig. 1, 2; Blainville, Ostéographie, p. 63; Giebel, Fauna der Vorwelt.
—— minutus					×				*Pliocene*, Marine sands of Montpellier, Gervais, Zool. et Pal. Fr. p. 107, pl. 8.
—— sp.					?				*Pliocene ?*, Boutonnet, Montpellier, De Luc (1772); Gervais, Zool. et Pal. Fr. p. 107, pl. 8, fig. 1.
—— cultridens (= *U. Etruscus*, Cuv.									See *Machairodus*.
—— sp.									*Diluvium*, Manea Marsh, Cambridgeshire, Owen, *op. cit.* p. 77.

FOSSIL MAMMALIA—*continued.*

× European area. † N. American. o S. American. * African. ‡ Asiatic. § Australasian.

Species.	Alluvial.	Diluvial.	Caverns.	Pleistocene.	Pliocene.	Miocene.	Eocene.	Cretaceous.	Oolitic.	Localities, Authorities, and References.
Ursus sp.		×								*Diluvium*, Hamburg, Zimmermann, in Leonh. and Bronn's Neues Jahrb. 1845, p. 73.
—— sp.		*								*Diluvial ?*, Osseous Breccia, Oran, Algeria, Milne-Edwards, in Ann. des Sc. Nat. ser. 2, t. vii. p. 216
—— Americanus		†								*Cavern*, Big Bone Cavern, United States of America (with bones of *Megalonyx*), Harland, Medic. and Phys. Researches, p. 329.
—— Brasiliensis										Lund. See *Nasua ursula*.
—— Sivalensis										Cautley and Falconer. See *Hyænarctos*.
Hyænarctos Sivalensis						‡				*Tertiary*, Siwalik hills, Cautley and Falconer, Asiatic Researches, t. xix. p. 1; Ann. des Sc. Nat. ser. 2, t. ix. p. 128, and (= *Ursus Sivalensis*,) Ann. des Sc. Nat. ser. 2, t. vii. p. 60; (= *Agriotherium*,) Wagner, Münch. Gelehrte Anz. 1837, t. v. p. 335; (= *Sivalours*, *Sivalarctos*, and *Amphiarctos*,) Blainville, Ostéographie, p. 68, and pp. 96 and 114; Owen, Odontography, 1845, p. 504, pl. 131; Pictet, Traité de Paléontologie, p. 189, pl. 11, fig. 7 and 8 (=*Amyxodon*, Fred. Cuvier).
Procyon priscus		*								*Diluvium ?*, Fissure in rock, filled with hardened clay and sand, Illinois, Leconte, Silliman's Journal, 1848, t. v. p. 102.
Nasua ursina			o							*Caverns*, Brazil, Lund, Oversigt Danske Forh. 1842; (= *Ursus Brasiliensis*,) Mém. de l'Acad. de Copenhague, t. ix. p. 198; Ann. Sc. Nat. ser. 2, t. xi. p. 224.
—— sp.			o							*Caverns*, Brazil, Lund, Mém. de l'Acad. de Copenhague, t. ix. p. 198; Ann. Sc. Nat. ser. 2, t xi. p. 225.
—— ? sp.							×			*Suessonian*, Tertiary clay, Meudon, Blainville, Ostéographie—*Subursus*, p. 72.
Meles taxus (seu vulgaris)										*Caverns*, England, Belgium, France, Germany, Auct.; (=*M. antediluvianus*), Schmerling, Ossem. Foss. des Cavernes de Liége, t. i. p. 159; (= *M. antiquus*,) Munster, Bayreuth Petref. p. 87; (= *M. vulgaris fossilis*,) H. v. Meyer, Palæologica, p. 47: see also M. de Serres, Dubreuil, and Jean-Jean, Ossem. Fluviatiles de Lunel-Viel; Desnoyers, Comptes Rendus de l'Acad. des Sc. 1842, ser. 1, p. 522; Gervais, Zool. et Pal. Fr. p. 117; Billaudel, Soc. Linn. de Bordeaux; Blainville, Ostéographic, p. 47; Nordmann, Ossem. Foss. trouvés à Odessa, p. 4; Giebel, Cav. de Sundwich in Leonh. and Bronn's Neues Jahrb. 1849, p. 67.
—— Morrenii		×								*Diluvium*, Terrain Crayeux de Ciply, Ch. and F. A. Morren, Revue Systématique des Nouv. Déc. d'Ossem. Foss. faites dans le Brabant méridional, p. 14; Laurillard, in C. D'Orbigny's Dict. d'Hist. Nat. t. ii. p. 593.

	A.	D.	C.	PL.	P.	M.	E.	CR.	O.	
Tylodon Hombresii										*Upper Parisian* of Alais; Gervais, Zool. et Pal. Fr. pl. 11; Pictet, Paléont. p. 193.
2. Canidæ.										
Arctocyon primævus							×			*Eocene* (*Suessonian*), Glauconie Inférieure, Environs de la Fère, Blainville, Ostéographie, "Petits Ours," p. 73; (= *Palæocyon* also, Blainville;) Pictet, Paléontologie, vol. i. p. 193; Atlas, pl. 3, fig. 1–3.
Amphicyon giganteus						×				*Miocene*, Terrains Tertiaires, Sansan, Lartet, Notice sur la Colline de Sansan, p. 16, and Ann. des Sc. Nat. t. vii. p. 119; Pictet, Paléontologie, vol. i. p. 194; Atlas, pl. 4, fig. 4–7; Blainville, Ostéographie, "Petits Ours," p. 78; (= *Amph. giganteus*,) Laurillard, in D'Orbigny's Dict. Univ. d'Hist. Nat. t. iii. p. 567; (= Chien d'une taille gigantesque,) Cuvier, Ossem. Foss. 4th edit. t. vii. p. 481, pl. 193, fig. 20, 21; *Miocene*, Chevilly (Loiret), Avaray (Loire-et-Cher); Sansan, (= *A. major*,) Blainville, Ostéographie, p. 113; Pictet, Paléontologie, p. 195.
—— major						×				*Miocene*, Sansan; Gervais, Zool. et Pal. Fr. p. 112; Lartet, Notice sur la Colline de Sansan, p. 16, et Ann. Sc. Nat. vii. p. 119; Pictet, Paléont. p. 195, pl. 3, fig. 1–7.
—— minor?						?				*Miocene*, Sansan, Blainville, Ostéog. "Subursus," p. 114; Lartet, Notice sur la Colline de Sansan, p. 19; Gervais, Zool. et Pal. Fr. p. 215; Pictet, Paléontologie, p. 195.
—— Blainvillii						×				*Miocene*, Digoin, Auvergne, Gervais, Zool. et Pal. Fr. p. 112 (?=*A lemanensis*, Pomel); Pictet, Paléontologie, vol. i. p. 195; Pomel, Bull. Soc. Géol. de Fr. 2 ser. t. iv. p. 379.
—— gracilis						×				*Miocene*, Auvergne, Pomel, Bull. Soc. Géol. ser. 2 (1846), t. iv. p. 379; (= *A. elaverensis* of Gervais, and jaw of *Canis Issiodorensis* of Blainville,) Pomel; (with doubt) Gervais, Zool. et Pal. Fr., explic. de la pl. 28, and pl. 112; (= *Cynelos*,) St. Gérand-le-Puy; Jourdan, in Musée Saint-Pierre à Lyon; *Miocene*, Auvergne, St. Gérand-le-Puy, (? = *Amphicyon*,) Pictet, Paléont. t. i. p. 195.
—— brevirostris						×				*Miocene?* Auvergne?, Croizet, Bull. Soc. Géol. t. iv. p. 25; (= *Amphicyon*,) Gervais, Zool. et Pal. Fr. p. 116; Blainville, Ostéographie, "Chiens," p. 122; Pomel, Bull. Soc. Géol. ser. 2, t. iii. p. 366; Calcaire lacustre de Georgovia, near Clermont, Puy-de-Dôme; Gervais, Zool. et Pal. p. 111.
—— dominans						×				*Miocene*, Germany, H. v. Meyer, in Leonh. and Bronn's Neues Jahrb. 1843, p. 388.
—— Klipsteinii						×				*Miocene*, Germany, H. v. Meyer, *op. cit.* 1843, p. 388.
—— intermedius							×			*Eocene*, H. v. Meyer, —— ?
—— Eseri							×			*Eocene*, Ulm, Pleininger, Leonh. and Bronn's Neues Jahrb. 1851, p. 512.
—— antiquus						×				*Miocene?*, Eppelsheim (= *Agnotherium*), Kaup, Ossem. Foss. du Mus. de Darmstadt, livr. ii. p. 28, pl. 1, fig. 3, 4; Blainville, Ostéog. "Subursus," p. 79; Gervais, Zool. et Pal. Fr. p. 13, descr. of pls.; Pictet, Paléont. vol. i. p. 195.
—— diaphorus						×				*Miocene?* Eppelsheim (= *Gulo*), Kaup, Karstens Archiv, t. v. p. 151; Ossem. Foss. de Darmstadt. t. ii. p. 15 (= ? *Amphicyon*); Pictet, Paléontologie, p. 195.
Pseudocyon Sansaniensis						×				*Miocene*, Sansan, Lartet, Notice sur la Colline de Sansan, p. 16.
Hemicyon Sansaniensis						×				*Miocene*, Sansan, Lartet, Notice sur la Colline de Sansan, p. 16; Gervais, Zool. et Pal. Fr., exp. pl. 28.

FOSSIL MAMMALIA—*continued.*

× European area. † N. American. o S. American. * African. ‡ Asiatic. § Australasian.

Species.	Alluvial.	Diluvial.	Caverns.	Pleistocene.	Pliocene.	Miocene.	Eocene.	Cretaceous.	Oolitic.	Localities, Authorities, and References.
Hyænodon	...	...	...	...	...	×	...	...	...	*Miocene?* Cournon, Puy-de-Dôme, Laizer and Parieu, Comptes Rendus de l'Acad. des Sc. 1838, sem. 2, p. 442; Ann. des Sc. Nat. ser. 2, t. xi. p. 27; Blainville, Comptes Rendus de l'Acad. des Sc. 1838, sem. 2, p. 1004; Pictet, Paléontologie, p. 196, pl. iii. f. 9.
——	...	...	...	...	...	...	?	...	...	*Eocene?*, Paris, Dujardin, Comptes Rendus, 1840, sem. 1, p. 134; Blainville, Ostéographie, "Petits Ours," p. 55; Pomel, (*Pterodon*,) Bull. Soc. Géol. de Fr. ser. 2, t. i. p. 591; t. iv. p. 385; Cuvier, (*Taxotherium, Pterodon*,) Ossem. Foss. 4th edit. t. v. p. 490; Gervais, Zool. et Pal. Fr. p. 128, pl. 26.
—— dasyuroides	...	...	...	...	...	...	×	...	...	*Parisien supérieur*, Plâtrières of Paris; (= *Thylacine* des Plâtrières,) Cuvier, Oss. Foss. ?(= *Pterodon dasyuroides*,) Gervais, Zool. et Pal. Fr. p. 130; (= *Pterodon dasyuroides*,) Blainville, Ann. Fr. et Étran. d'Anatomie et de Physiologie, 1839, t. iii. p. 23; (= *Pterodon Parisiensis*,) Blainville, Ostéographie, "Subursus," p. 48, pl. 12.
—— Cuvieri	...	...	...	...	...	...	×	...	...	*Eocene*, Plâtrières de Paris; (= *H. Parisiensis* of some authors;) Pomel, Bull. Soc. Géol. Fr., 2 ser. t. iv. p. 392; Gervais, Zool. et Pal. Fr. p. 129, and pl. 11, 12, 15, 25; (= Carnassier voisin des Coatés et des Ratous,) Cuvier, Oss. Foss. t. iii. p. 269, pl. 69, f. 2–4; (= *Nasua Parisiensis*,) H. v. Meyer, Palæont. p. 47; (= *Taxotherium Parisiense*,) Blainville, Ostéographie, "Subursus," p. 55; (= *Hyænodon Parisiensis*,) Laurillard, in D'Orbigny's Dict. de Nat. Hist. t. iv. p. 768; Atlas, pl. 7, fig. 10, 11; (= *Taxoxylum Nicensis*, of Keferstein, Naturg. t. ii. p. 201, *vide* H. v. Meyer, in Bronn's Index Palæontol.); Pictet, Paléont. i. p. 200, pl. 3, fig. 12–12.
—— Requieni	...	...	...	...	...	...	×	...	...	*Eocene*, Dépôts Éocènes supérieures, Debruge, Apt, and Alais, Gervais, Comptes Rendus de l'Acad. des Sc. 1846, t. xxvi. p. 491; Ann. des Sc. Nat. ser. 3, t. v. p. 257; Zool. et Pal. Fr. p. 129, and pl. 11, 12, 15, 25.
—— minor	...	...	...	...	...	...	×	...	...	*Eocene*, Dépôt Éocène Tertiaire, Alais, Gervais, Zool. et Pal. Fr. p. 129, pl. 25.
—— leptorhynchus	...	...	...	...	...	×	...	...	...	*Miocene*, Terrains Tertiaires, Miocènes inférieures, Laizer and Parieu, Comptes Rendus de l'Acad. des Sc. 1838, sem. 2, p. 442; Ann. des Sc. Nat. ser. 2, t. xi. p. 27; Blainville, Ostéographie, "Chiens," p. 111, and "Subursus," p. 104; (= Dasyure d'Auvergne,) Buckland, Bridgewater Treatise, Geology, translation by Doyère, t. i. p. 544; (= *Pterodon leptorhynchus*,) Puy-de-Dôme and Haute-Loire, Pomel, Bull. Soc. Géol. ser. 2, t. iv. p. 392; Pictet, Paléontologie, p. 200; Atlas, pl. 3, fig. 9.

	A.	D.	C.	PL.	P.	M.	E.	CR.	O.	
Hyænodon leptorhynchus?						×				*Miocene* ?, Calcaire lacustre de Puy, Aymard, Ann. Soc. de Puy, t. xii. p. 249; Pictet, Paléontologie, p. 200.
—— brachyrhynchus						×				*Miocene* ?, Bords du Tarn près de Rabastiens (= *Pterodon brachyrhynchus*,) Dujardin, Comptes Rendus de l'Acad. des Sc. 1840, sem. 1, p. 134; Blainville, Ostéographie, "Chiens," p. 113; Laurillard, in D'Orbigny's Dict. de Nat. Hist. t. vi. p. 667; Pomel, Bull. Soc. Géol. t. iv. p. 332; Pictet, Paléontologie, p. 200; Atlas, pl. 3, fig. 8.
Acanthodon ferox						×				—— ?, Terrains Tertiaires de Weisenau, H. v. Meyer, in Leonh. and Bronn's Neues Jahrb. 1843, p. 702; Pictet, Paléontologie, vol. i. p. 201.
Harpagodon maximus						×				—— ?, Bohnerz d'Alstadt, près de Mœszkirch, H. v. Meyer, in Leonh. and Bronn's Neues Jahrb. 1837, p. 675, 1838, p. 413; Pictet, Paléontologie, vol. i. p. 201.
Canis Parisiensis							×			*Eocene*, Plâtrières de Montmartre, Cuvier, Ossem. Foss. 4th edit. t. v. p. 486; Laurillard, Dict. Hist. Nat. t. iii. p. 570; Blainville, (= *C. lagopus fossilis*,) Ostéographie, "Chiens," p. 107, pl. 13; Pictet, Paléontologie, p. 202; Gervais, Pal. et Zool. p. 111.
—— gypsorum?							×			*Eocene*, Plâtrières de Montmartre, Cuvier, Ossem. Foss. 4th edit. t. v. p. 514; Blainville, Ostéog. "Canis," p. 108.
? —— viverroides: sec. *Cynodon, s.g. Cyotherium.*										
—— brevirostris										*Miocene*, Auvergne. See *Amphicyon brevirostris*; and *Felis*.
—— Issiodorensis (*See* Felis.)										*Pliocene*, Auvergne, (? = *C. Issiodorensis* vel *C. borbonidus*,) Pictet, Paléontologie, p. 203; Blainville, Ostéographie, "Chiens," p. 123, pl. 13 (*C. borbonidus* =); *Pliocene*, Issoire, Bravard, Coll. Brit. Mus.; (= *C. meganastoides*), Pomel, Bull. Soc. Géol. t. xiv. p. 40; (? = *Amphicyon*,) Pomel; Gervais, Pal. et Fr. p. 110.
Canis familiaris fossilis		×	×							*Diluvial*, Europe, Marcel de Serres, Recherches sur les Ossemens Fluviatiles des Cavernes de Lunel-Viel?, p. 73; Pictet, Paléontologie, t. i. p. 203; Blainville, Ostéographie, "Chiens," p. 131; *Caverns*, France, Belgium, Germany; *Canis propagator* of Kaup, Isis, 1834, p. 535 (= *C. familiaris*), H. v. Meyer and Bronn, Index Paleontologicus, p. 213; Marcel de Serres, Mém. Mus. t. xviii. p. 339.
—— (Lupus) spelæus		×	×							*Caverns*, Europe, Goldfuss, Umgebungen von Muggendorff, t. i. p. 28; Nova Act. Acad. Nat. Cur. t. xi. 2, p. 451; Cuvier, Ossem. Foss. 4th edit. t. vii. p. 465; Owen, British Foss. Mammalia, p. 123; Nordmann, Ossem. trouvés près d'Odessa, p. 4; *et alii.*
——				?						*Bone-breccia*, Sardinia and France.
—— ——		×								*Diluvial*, Val d'Arno, Fischer (Loup des Tourbières), Bull. Soc. Moscou, 1846, t. xix.; Paléontologie, ii. p. 391; Pictet, Paléontologie, p. 205; (*Canis lupus spelæus minor* = *C. spelæus*, vide) Blainville, Ostéographie, "Chiens," p. 103; Italy, Wagner, 1829, Isis, t. iv. p. 986.
—— (Vulpes) spelæus			×							*Caverns*, Europe; Cuvier, Ossem. Foss. 4th edit. t. vii. p. 471; Owen, Brit. Foss. Mam. p. 134; ? in part species from Auvergne, Pictet, Paléontologie, p. 205; Hébert, Fossiles de l'Oise, in Bull. Soc. Géol. ser. 2, t. vi. p. 605; Nordmann, Ossem. d'Odessa.

FOSSIL MAMMALIA—*continued.*

× European area. † N. American. o S. American. * African. ‡ Asiatic. § Australasian.

Species.	Alluvial.	Diluvial.	Caverns.	Pleistocene.	Pliocene.	Miocene.	Eocene.	Cretaceous.	Oolitic.	Localities, Authorities, and References.
Canis Neschersensis?		×								*Diluvium*, Neschers, near Issoire, Puy-de-Dôme; CROIZET, Coll.; BLAINVILLE, Ostéog. "Chieus," p. 125; GERVAIS, Zool. et Pal. Fr. p. 110; ? = *Canis lycaon*, recent, of the Pyrenees, *fide* BLAINVILLE, *op. cit.*
—— juvillacus?				×						*Pleistocene*, Tour du Bolade, Puy-de-Dôme; BRAVARD (undescribed); PICTET, Paléont. p. 205.
—— medius?				×						*Pleistocene?*, ——?, BRAVARD (undescribed), *op. cit.* p. 205.
—— Tormellii?			×							*Cavern?*, ——?, CROIZET (undescribed), *op. cit.* p. 205.
—— Buladi			×							*Cavern?*, ——?, CROIZET (undescribed), *op. cit.* p. 205.
—— ferreo-jurassicus?	?					?				*Diluvium? or Miocene?*, Bohnerz de l'Albe de Souabe, JAEGER (= *Lycotherium* genus); (= *C. lupus ferreo-jurassicus* and *C. vulpes ferreo-jurassicus*, JAEGER,) Foss. Säug. Würt. t. i.; BRONN, Lethæa, t. ii. p. 832; LEONH. and BRONN, Neues Jahrb. 1837, p. 735; PICTET, Paléontologie, p. 205.
—— sp.						×				*Tertiary*, Himalaya, CAUTLEY and FALCONER, Asiatic Journal, 1835?, 559?
—— protalopex			o							*Caverns*, Brazil, LUND (? = *C. Azzaræ*), Mém. de l'Acad. de Copenhague, 1841, t. viii.; PICTET, Paléont. p. 206.
—— sp.	×	×	×							*Diluvial*, *Caverns*, *Alluvial*, Europe.
Canis fulvicaudus?			o							*Caverns*, Brazil, LUND, Mém. de l'Acad. de Copenhague, 1841, t. viii.; Overs. Dansk. Forh. 1842; Isis, 1844, p. 815–819; Ann. Sc. Nat. ser. 2, t. xi. p. 214; (= or near recent *C. fulvicaudus*, LINNÆUS,) PICTET, Paléontologie, p. 206.
—— robustior			o							*Caverns*, Brazil, LUND, *op. cit.* vol. viii.; Ann. Sc. Nat. ser. 2, t. xi. p. 214.
—— lycodes			o							*Caverns*, Brazil, LUND, *op. cit.* vol. viii.; Ann. Sc. Nat. ser. 2, t. xi. p. 214.
—— incertus			o							*Caverns*, Brazil, D'ORBIGNY, Voyage en Amérique; Paléontologie, p. 141, pl. 9, fig. 5.
Cynodon Parisiensis							×			*Eocene*, Gypsum, Paris, AYMARD, Essai sur l'Entelodon, p. 20; Ann. Soc. d'Agr. de Puy, t. xii. p. 244, and t. xiv. p. 112; Monographie des Cynodon, in Ann. Soc. d'Agr. de Puy, 1850, t. xv. p. 92; (= *Viverra Parisiensis*,) CUVIER, Ossem. Foss. 4th edit. t. v. p. 496, pl. 151, fig. 12; BLAINVILLE, Ostéog. "Chiens," p. 109; GERVAIS, Zool. et Pal. Fr. p. 112; (= *Cyotherium*,) AYMARD, Ann. Soc. d'Agr. de Puy, t. xiv. p. 110, 115; (=*Cynodictis*), BRAVARD and POMEL, PICTET, Paléont. p. 208.
—— lacustris							×			*Eocene?*, Lignites of Debruge, Butte de Peréal, près Apt (Vaucluse), GERVAIS, Comptes Rendus de l'Acad. des Sc. t. xxx. p. 603; Zool. et Pal. Fr. p. 217, pl. 15, fig. 3, pl. 25 and 26; PICTET, Paléontologie, p. 208; Atlas, pl. 3, fig. 13–15.

	A.	D.	C.	PL.	P.	M.	E.	CR.	O.	
Cynodon velaunus						×				*Lower Miocene*, Marnes lacustres, Puy-en-Velay, AYMARD, Ann. Soc. de Puy, t. xii. p. 244, et t. xv. p. 118; GERVAIS, Zool. et Pal. Fr. pl. 26, p. 218.
—— palustris						×				*Lower Miocene*, Marnes lacustres, Puy-en-Velay, AYMARD, *op. cit.* t. xiv. p. 113, xv. p. 118; GERVAIS, *op. cit.* pl. 25 et 26, p. 218.
—— martrides?						×				*Lower Miocene*, Marnes lacustres, Puy-en-Velay, (= *Elocyon martrides*,) AYMARD, *op. cit.* t. xiv. p. 110; GERVAIS, Zool. et Pal. Fr. p. 219.
Galecynus Œningensis					×					*Pliocene*, Œningen, (= *Canis vulpes*,) MURCHISON, and MANTELL, Trans. Geol. Soc. ser. 2, vol. iii. p. 277, 291, 1830; Phil. Mag. 1830, p. 207; BLAINVILLE, Ostéographie, "Chiens," p. 106; (= *Galecynus*,) OWEN, Quart. Journ. Geol. Soc. vol. iii. 1847, p. 55; (= *Canis palustris*,) H. v. MEYER, in Leonh. und Bronn's Neues Jahrb. 1843, p. 701, and Zur Fauna der Vorwelt, Œningen, p. 4, pl. 1; PICTET, Paléont. p. 209.
Palæocyon troglodytes			o							*Caverns*, Brazil, (LUND, *non* BLAINVILLE, Palæocyon,) LUND, Overs. Danske Forhandl. 1842; (= *Canis troglodytes*,) LUND, Ann. Sc. Nat. ser. 2, t. xi. p. 214, t. xiii. p. 312; PICTET, Paléontologie, p. 209.
—— validus			o							*Caverns*, Brazil, LUND, *op. cit.* 1842.
Speothos pacivora			o							*Caverns*, Brazil, LUND, Mém. de l'Ac. de Copen., t. viii. pl. 19, fig. 1, 2; PICTET, Paléontologie, p. 210.
? Galeotherium sp., JAEGER (*non* WAGNER)						×				*Miocene ?*, Bohnerz de la Molasse de la Souabe supérieure, JAEGER, Foss. Säug. Würt. p. 71, pl. 10, fig. 43–47; PICTET, Paléontologie, p. 221; H. v. MEYER ?, p.
3. VIVERRIDÆ.										
Viverra antiqua						×				*Miocene*, Mont St. Gérand, Auvergne, BLAINVILLE, Ostéographie, "Civettes," pp. 69 and 71, pl. 13; PICTET, Paléontologie, vol. ii. p. 211; (= Civette d'Auvergne,) CROIZET, —— ?; GERVAIS, Zool. et Pal. Fr. pl. 114.
—— primæva						×				*Miocene*, Auvergne, POMEL, Bull. Soc. Géol. ser. 2, t. iii. p. 366.
—— zibethoides?						×				*Miocene*, Sansan (= Zibeth de Sansan), LARTET, Notice Coll. Sansan, pl. iv. f. 2; BLAINVILLE, Ostéographie, p. 75; Ann. des Sc. Nat. ser. 2, t. vii. p. 119; PICTET, Paléontologie, vol. i. p. 211, Atlas, pl. 4, fig. 2.
—— Sansaniensis						×				*Miocene*, Sansan, LARTET, Notice sur la Colline de Sansan; GERVAIS, Zool. et Pal. Fr. pl. 222.
—— incerta						×				*Miocene*, Sansan, LARTET, *op. cit.*
—— Simorrensis						×				*Miocene*, Simorre, LARTET, *op. cit.*; PICTET, Paléontologie, p. 211.
—— ferreo-jurassica?						×				*Miocene ?*, Bohnerz de l'Albe de Souabe, JAEGER, Säugeth. 15, t. 5, f. 13, 14; PICTET, Paléontologie, vol. i. p. 212, and p. 205.
—— sp.			×							*Caverns*, Lunel-Viel, MARCEL DE SERRES, DUBREUIL, and JEAN-JEAN, Recherches sur les Cavernes de Lunel-Viel, p. 247.
—— sp.							‡			*Eocene ?*, Tertiary, Bengal, PENTLAND, Trans. Geol. Soc. ser. 2, vol. ii. p. 45, fig. 6.
—— sp.?			§							*Caverns*, New Holland, CLIFT ?; PICTET, Paléontologie, t. i. p. 212; Sansan, BLAINVILLE; (= *Galerix*,) *vide* PICTET, Pal. p. 212.

FOSSIL MAMMALIA—*continued.*

× European area. † N. American. o S. American. * African. ‡ Asiatic. § Australasian.

Species.	Alluvial.	Diluvial.	Caverns.	Pleistocene.	Pliocene.	Miocene.	Eocene.	Cretaceous.	Oolitic.	Localities, Authorities, and References.
(Viverra *exilis* =) Palæonictis gigante	...	...	...	...	...	...	×	...	...	*Eocene ?* (*Suessonien*), Lignites of the Soissonnais, at Muirancourt, near Noyon (Oise), Blainville, Ostéographie, "Civettes," p. 76, pl. 13; Gervais, Zool. et Pal. Fr. p. 131, pl. 25; (= molar of Loutre from *Suessonien* of Meudon,) C. D'Orbigny, Dict. Hist. Nat ?; (= *Canis viverroides* des Plâtrières,) Blainville, Ostéog. p. 76; Pictet, Paléontologie, p. 212; Atlas, pl. 4. fig. 3.
4. Mustelidæ.										
Gulo spelæus	...	...	×	...	...	...	...	...	...	*Caverns*, Gaylenreuth, Sömmerring, —— ?; Belgium, Schmerling; France ?, Gervais, Zool. et Pal. Fr. p. 117; Pictet, p. 214; Atlas, pl. 4, fig. 5; Goldfuss, Nova Acta Nat. Cur. ix. p. 314; Cuvier, Ossem. Foss. 4th edit. t. vii. p. 500.
Galictis sp.	...	...	o	...	...	...	...	...	...	*Caverns*, Brazil, Lund, (= *Eirara*,) Ann. des Sc. Nat. sér. 2, t. xi. p. 225.
Mephitis sp.	...	...	o	...	...	...	...	...	...	*Caverns*, Brazil, Lund, Ann. des Sc. Nat. ser. 2, t. xi. p. 225; Pictet, Paléontologie, p. 215.
Palæomephitis Steinheimensis	...	...	...	...	×	...	...	...	...	*Pliocene ?*, Freshwater Limestone, Steinheim, Jaeger, Foss. Würt. p. 78, pl. 10, fig. 7, 8; (= *Palæobassaris*,) Paul de Wurt, —— ?; Pictet, Paléont. p. 205.
Mydaus sp.	...	...	...	...	...	...	×	...	...	*Suessonien*, Meudon, Blainville, Ostéographie, "Subursus," p. 47; Pictet, Paléont. p. 26.
Mustela minuta	...	...	...	...	...	×	...	...	...	*Lower Miocene*, Auvergne, Gervais, Zool. et Pal. Fr. pl. 27; Pictet, Paléont. p. 216.
—— genettoides	...	...	...	...	...	×	...	...	...	*Upper Miocene*, Sansan, Blainville, Ostéographie, "Martes," p. 61, pl. 14.
—— hydrocyon	...	...	...	...	...	×	...	...	...	*Upper Miocene*, Sansan, Gervais, Zool. et Pal. Fr. p. 118, pl. 23; (= *Hydrocyon Sansanensis*,) Lartet, Notice sur la Colline de Sansan, p. 17; Pictet, Paléont. p. 216.
—— taxodon	...	...	...	...	...	×	...	...	...	*Upper Miocene*, Sansan, Gervais, Zool. et Pal. Fr. p. 118, pl. 23; (= *Taxodon Sansaniensis*,) Lartet, Notice sur la Colline de Sansan; Pictet, Paléont. p. 216.
—— Zorilloides ?	...	...	...	...	...	×	...	...	...	*Upper Miocene*, Sansan, Lartet, Notice sur la Colline de Sansan, p. 17; Pictet, Paléont. p. 216.
—— incerta	...	...	...	...	...	×	...	...	...	*Upper Miocene*, Sansan, Lartet, Coll.; (= *Thalassides*,) Pictet, Paléont. p. 216.
—— sp.	...	...	...	...	...	...	?	...	...	*Eocene ?*, Terrain Tertiaire lacustre, Georgensgmünd, Bavaria, Count de Münster ?; Pictet, Paléont. p. 216.
—— sp.	...	×	×	...	...	...	...	...	...	*Caverns*, Liége, Schmerling, Cavernes de Liége; France, Gervais, *op. cit.*; Desnoyers ?; Billaudel ?, etc.; *Diluvium*, Odessa, Nordmann, Ossem. Foss. trouvés à Odessa; *Upper Gravels*, Geneva, Pictet, Paléontologie, p. 217.
—— elongata	...	...	...	...	...	×	...	...	...	*Upper Miocene* of Montpellier, Gervais, Mém. Acad. Sc. Montpellier, 1850, t. i. p. 406; Zool. et Pal. Fr. p. 248, pl. 22; Pictet, Paléont. p. 216.

	A.	D.	C.	PL.	P.	M.	E.	CR.	O.	
Mustela ardea					×					*Pliocene*, Sub-volcanic deposits, Auvergne, Gervais, Zool. et Pal. Fr. pl. 27, fig. 5; (= *Marta ardea*), Bravard, Coll. du Mus.; (= Marte lutroïde,) Pomel. Bull. Soc. Géol. de France, 1846, p. 205.
Soricictis elegans						×				*Miocene*, Auvergne, at Saint Gérand-le-Puy, Pomel (in coll. M. Feignoux), ?; (= *Amphichneumon*), Pomel, in Coll. British Museum; Gervais, Zool. et Pal. Fr. explic. pl. 28; Pictet, Paléont. p. 213.
—— leptorhyncha						×				*Miocene*, Saint Gérand-le-Puy, Pomel (in coll. M. Feignoux), —— ?; Gervais. *op. cit.* explic. pl. 28.
—— ? sp.							×			*Eocene ?*, *Terrains récents*, Greece (*Eocene* or *Miocene* of Pikermi); (= *Galeotherium*), Wagner, Mém. de l'Acad. de Munich, t. iii. p. 11, pl. 1, fig. 4, 5 (non *Galeotherium*, Jaeger); Pictet, Paléont. p. 213.
Paleogale pulchella						×				*Miocene*, Weisenau, H. v. Meyer, in Leonh. and Bronn's Neues Jahrb. 1846, p. 474; Pictet, Pal. p. 218.
—— fecunda						×				*Miocene*, Weisenau, H. v. Meyer, *op. cit.* p. 474; Pictet, Pal. p. 218.
Putorius zorillinus					×					*Pliocene*, Subvolcanic deposits, Auvergne, Bravard, Bull. Soc. Géol. ser. 2, t. iii. p. 205; (= *Mustela zorilloides*,) Gervais, Zool. et Pal. Fr. p. 251.
—— Sansaniensis						×				*Miocene*, Sansan, Lartet, Notice sur la Coll. de Sansan; (? =) Pictet, Paléontologie, p. 218.
—— incertus?						×				*Miocene*, Sansan, Lartet, *op. cit.*; (? =) Pictet, Paléontologie, p. 218.
—— antiquus		×	×							*Caverns*, Pondres (Gard), etc., France, H. v. Meyer, Palæologica, p. 54; (= Putois fossile,) Cuvier, Ossem. Foss. 4th edit. t. viii. p. 484; Lunel-Viel, M. de Serres, Recher. sur les Cav. de Lunel-Viel; *Diluvium*, Avaray, near Beaugenez; *Caverns*, Liége, Schmerling, Cav. de Liége; Kirkdale, Buckland, Rel. Dil.; *Breccia*, Vendargues (Hérault) and Montmorency.
—— vulgaris?		×								*Diluvium*, Gravels, neighbourhood of Geneva, Pictet, Paléont. p. 218; Auvergne, Pomel, Bull, Soc. Géol. t. iii. p. 204.
Mustela vulgaris		×	×							*Diluvium*, Geneva, Auvergne, Pomel, Bull. Soc. Géol. t. iii. p. 204; Pictet, *op. cit.* p. 218; *Caverns*, Kirkdale, Buckland, Rel. Dil.; Cuvier, Ossem. Foss. 4th edit. t. vii. p. 500; Liége, Schmerling, Cav. de Liége.
Putorius ermineus		×								*Diluvium ?*, Osseous Breccia, environs of Beremend, near the Drave, Leonh. and Bronn, Neues Jahrb. 1851, p. 679; Owen, Brit. Foss. Mam. and Birds, p. 116.
—— furo ?		×								*Diluvium*, Auvergne, Pomel, Bull. Soc. Géol. t. iii. p. 204.
—— nudipes?		×								*Diluvium*, Auvergne, Pomel, *op. cit.* t. iii. p. 204.
Putoriodus sp.						×				*Miocene*, Calcaires lacustres, environs of Issoire, Auvergne, Gervais, Zool. et Pal. Fr. explic. pl. 27; Pictet, Paléont. p. 219.
Lutra dubia						×				*Miocene*, Sansan, Lartet, Notice sur la Colline de Sansan; Blainville, Ostéographie, "Martin," p. 76, pl. 14; Pictet, Paléont. p. 219.

FOSSIL MAMMALIA—*continued.*

× European area. † N. American. o S. American. * African. ‡ Asiatic. § Australasian.

Species.	Alluvial.	Diluvial.	Caverns.	Pleistocene.	Pliocene.	Miocene.	Eocene.	Cretaceous.	Oolitic.	Localities, Authorities, and References.
Lutra Bravardi					×					*Pliocene,* Issoire and Perrier, Pomel, Bull. Soc. Géol. t. xiv. p. 168, pl. 3, fig. 1, 2; (= *L. claveris,*) Croizet, in Huot ?, Cours de Géologie, t. 1, p. 265; (= in part *L. Clermontensis,*) Croizet, *op. cit.;* Pictet, Paléont. p. 219.
—— antiqua		×								*Diluvium,* Fens, Cambridgeshire, H. v. Meyer, Palæologica, p. 55; Pictet, Paléont. p. 220.
—— spelæa ?			×							*Caverns,* Lunel-Viel, M. de Serres, Cav. de Lunel-Viel, p. 70; Pictet, Paléont. p. 220.
—— ferreo-Jurassica ?						?				*Miocene ?,* Bohnerz of Souabe, Jaeger, Foss. Säug. Würt. p. 13; Pictet, Paléont. p. 220.
Potamotherium Valetoni						×				*Miocene ?,* —— ?, Geoffroy Saint-Hilaire, Études Progressives d'un Naturaliste, p. 91; (= ? *Lutrictis;*) *Miocene,* Calcaire lacustre d'Auvergne, Saint-Gérand-le-Puy, Pomel, Bull. Soc. Géol. ser. 2, t. iv. p. 380, pl. 4, fig. 5; (= ?) Pictet, Paléontologie, p. 220; Atlas, pl. 4, fig. 10; (= ? *Stephanodon,*) H. v. Meyer, in Leonh. and Bronn's Neues Jahrb. 1847, p. 143; (= ? *Monbachensis,* in British Museum;) Gervais, Zool. et Pal. Fr. explic. pl. 28.
Plesiogale angustifrons						×				*Lower Miocene,* Limestone, Saint Gérand-le-Puy, Allier, Bull. Soc. Géol. sér. 2, t. iv. p. 385; Laurillard, in D'Orbigny's Dict. de Nat. Hist. t. x. p. 268; Pictet, Paléont. p. 217, Atlas, pl. 4, fig. 7; Gervais, Zool. et Pal. Fr. p. 119.
—— elegans						×				*Miocene,* Saint-Gérand-le-Puy, Auvergne, Pomel, Coll. British Museum; Pictet, Paléontologie, p. 217.
—— sectoria						×				*Miocene ?* Cournon ?; (= *Plesiogale,*) in coll. British Museum; (= *Mustela sectoria,*) Gervais, et Pal. Fr. explic. pl. 28; Pictet, Paléont. p. 217.
Plesictis sp.						×				*Lower Miocene,* Limestone, Saint-Gérand-le-Puy, Pomel, Bull. Soc. Géol. ser. 2, t. iv. p. 379; (= *Mustela plesictis,*) Laizer and Parien, Mag. de Zool. 1839, pl. 5; Laurillard, in D'Orbigny's Dict. Univer. d'Hist. Nat. t. x. p. 268; Blainville, Ostéographie, p. 62, pl. 14; Gervais, Zool. Zool. et Pal. Fr. p. 119.
—— Croizeti						×				*Lower Miocene,* Limestone, Saint-Gérand-le-Puy, Pomel, *op. cit.* p. 380; Pictet, Paléontologie, p. 218; Atlas, pl. 4, fig. 8.
Thalassictis robusta						×				*Miocene,* Marine beds of Bessarabia, Nordmann, Oss. trouvés près d'Odessa ?; Pictet, Paléont. p. 221; Gervais, Zool. et Pal. Fr. p. 20.
—— incerta						×				*Miocene* (? analogous to *Hyæna hipparionum*), Sansan, Gervais, Zool. et Pal. Fr. p. 120, pl. 23; Pictet, Paléont. p. 221; (= *Mustela incerta,*) Lartet, Notice sur la Coll. de Sansan.

	A.	D.	C.	PL.	P.	M.	E.	CR.	O.	
5. Hyænidæ.										
Hyæna hipparionum					×					*Pliocene*, Dépôt fluviatile à Hipparions de Cucuron (Vaucluse), Gervais, in Ann. Sc. Nat. ser. 3, t. v. p. 261; Zool. et Pal. Fr. p. 121, pl. 12, fig. 1; Pictet, Paléontologie, p. 222, pl. 5, fig. 1–6?
—— sp.					×					*Pliocene*, Marine sands, Montpellier, Gervais, Zool. et Pal. Fr. explic. pl. 30; Pictet, p. 222.
—— sp.						×				*Miocene*, Molasses de la Molière, near the Lake of Neufchâtel, Pictet, p. 222.
—— Perrieri					×					*Pliocene ?*, Terrains meubles, montagne de Perrier (terrains Tertiaires supérieurs), Puy-de-Dôme, Croizet and Jobert, Recher. Ossem. Foss. du Puy-de-Dôme, p. 169; Pictet, Paléontologie, p. 223.
—— Arvernensis					×					*Pliocene ?*, Terrain alluvio-volcanique ancien de Vialette, Puy-en-Velay (communication inédite de M. Aymard), Croizet et Jobert, *op. cit.* p. 169; Pictet, Paléont. p. 223; Atlas, pl. 5, fig. 6.
—— dubia ?					×					*Pliocene ?*, Terrains Tertiaires supérieurs, Puy-de-Dôme, Croizet and Jobert, *op. cit.* p. 169; Pictet, Paléontologie, p. 223.
—— brevirostris					×					*Pliocene ?*, Terrains Tertiaires supérieurs ?, Sainzelle, near Le Puy; Gervais, Zool. et Pal. Fr. p. 122.
—— spelæa		×	×							*Caverns*, Europe, Goldfuss, Nova Acta, t. xi. p. 459, pl. 57; (= Hyène fossile,) Cuvier, Ossem. Fossiles, 4th edit. t. vii. p. 334; Pictet, Paléontologie, p. 224; Atlas, pl. 5, fig. 5; Blainville, Ostéographie, "Hyènes," p. 42, pl. 6 and 7; Owen, British Foss. Mammalia, p. 138; Gervais, Zool. et Pal. Fr. p. 122; Giebel, in Leonh. and Bronn's Neues Jahrb. 1849, p. 64; (= genus *Crocotta*,) Kaup, Oss. de Darmstadt, p. 122; *Diluvium*, Bone-bed, Folkestone, Mackie, in Quart. Journ. Geol. Soc. vol. vii. p. 261; (= *H. spelæa major*, Goldfuss, *vide*) Wagner,
—— Monspessulana			×							*Caverns*, —— ?, Christol, in Mém. de la Soc. d'Hist. Nat. de Paris, t. iv. p. 376; Ann. des Sc. Nat. Feb. 1828; (= *Hyæna prisca*,) Marcel de Serres, Dubreuil, and Jean-Jean, Mém. du Mus. d'Hist. Nat. t. xvii. p. 278; Cavernes de Lunel-Viel, p. 80; Gervais, Zool. et Pal. Fr. p. 121; Blainville, Ostéog. "Hyæna," p. 49.
—— intermedia			×							*Caverns*, Lunel-Viel, Marcel de Serres, Cavernes de Lunel-Viel, p. 80; Gervais, Zool. et Pal. Fr. p. 122; Pictet, Paléontologie, p. 224.
—— Sivalensis						×				*Upper Tertiary* beds of the Himalaya, Cautley and Falconer, in Asiat. Journ. of Bengal, 1835, p. 559; Ann. des Sc. Nat. ser. 2, t. vii. p. 61; Pictet, Paléontologie, p. 224.
6. Felidæ.										
Felis sp. ?							×			*Eocene ?*, Gypsum, (Parisien supérieur,) Blainville, Ostéographie, "Felis," p. 153; (= Civet,) Cuvier, Ossem. Foss. 4th edit. t. v. p. 513; Pictet, Paléont. p. 226.
—— media						×				*Miocene*, Terrains Miocènes supérieurs, Sansan, Lartet, Notice sur la Colline de Sansan, p. 19.
—— pygmæa						×				*Miocene*, Terrains Miocènes supérieurs ?, Sansan ?, Lartet, *op. cit.* p. 19; Gervais, Zool. et Pal. Fr. explic. pl. 23; Pictet, Paléont. p. 226.
—— aphanista						×				*Miocene*, Sables d'Eppelsheim, Kaup, Ossem. Foss. de Darmstadt, livr. 2, p. 18, pl. 1 and 2, and in Karsten's Archiv. v. 1832, pl. 1, fig. 3–5.

FOSSIL MAMMALIA—*continued.*

× European area. † N. American. o S. American. * African. ‡ Asiatic. § Australasian.

Species.	Alluvial.	Diluvial.	Caverns.	Pleistocene.	Pliocene.	Miocene.	Eocene.	Cretaceous.	Oolitic.	Localities, Authorities, and References.
Felis ogygia	...	...	...	...	...	×	...	...	...	*Miocene*, Sables d'Eppelsheim, Kaup, *op. cit.* p. 21, pl. 2, fig. 3, 4, and pl. 1, fig. 6.
—— prisca	...	...	...	...	...	×	..	...	...	*Miocene*, Sables d'Eppelsheim, Kaup, *op. cit.* p. 20, pl. 2, fig. 2; Blainville, Ostéog. p. 118.
—— antediluviana	...	...	...	...	...	×	...	...	...	*Miocene*, Sables d'Eppelsheim, Kaup, *op. cit.* p. 23, pl. 2, fig. 5.
—— Arvernensis	...	...	...	...	×	...	...	...	...	*Pliocene ?*, Terrains Tertiaires supérieurs, (arenaceous beds), Puy-de-Dôme, Croizet and Jobert, Recherch. sur les Ossem. Foss. du Puy-de-Dôme, 1828, tom. i. pp. 202, 215; Blainville, Ostéog. p. 126; Pictet, Paléont. p. 227.
—— Pardinensis	...	...	...	...	×	...	...	...	...	*Pliocene ?*, Arenaceous beds, Puy-de-Dôme, Croizet and Jobert, *op. cit.* p. 201; (?) Pictet, Paléont. p. 227.
—— brevirostris	...	...	...	...	×	...	...	...	...	*Pliocene ?*, Arenaceous beds, Puy-de-Dôme, Croizet and Jobert, *op. cit.* tom. i. p. 196; (?) Pictet, Paléont. p. 227.
—— Issiodorensis	...	...	...	...	×	...	...	...	...	*Pliocene ?*, Arenaceous beds, Puy-de-Dôme, Croizet and Jobert, *op. cit.* tom. i.; (?) Pictet, Paléont. p. 227.
—— leptorhina	...	...	...	...	...	...	...	...	...	—— ? —— ? —— ?, Bravard, Collection —— ?; Gervais, Zool. et Pal. Fr. descr. pl. 18, fig. 3, 4; Blainville, Ostéographie, "Felis;" Pictet, Paléont. p. 228.
—— (*leopardus*)	...	...	...	...	...	...	...	...	...	*Cavern*, Lunel-Viel, De Serres, etc.; Oss. Foss. C. de Lunel-Viel, p. 112, pl. 9; Owen, Ann. Nat. Hist. vol. iv. p. 186 (1840); (? = *F. antiqua*,) Blainville, Ostéog. p. 120.
—— Perrieri ?	...	...	...	...	...	...	...	...	...	—— ? —— ?, Bravard, ms. Catalogue.
—— elata ?	...	...	...	...	...	...	...	...	...	—— ? —— ?, Bravard, ms. Catalogue.
—— juvillaca	...	...	...	...	...	...	...	...	...	—— ? —— ?, Bravard, ms. Catalogue.
—— Christolii	...	...	...	...	...	...	...	...	...	—— ?, Terrain Tertiaire marin supérieur, Montpellier, Gervais, Zool. et Pal. Fr. p. 124, pl. 8, fig. 2; Pictet, Paléont. p. 228.
—— sp.	...	...	...	...	...	...	...	...	...	—— ?, Terrain Tertiaire marin supérieur, Montpellier, (= size of lion,) Gervais, Zool. et Pal. Fr. explic. pl. 30; Pictet, Paléont. p. 228.
—— sev. sp.	...	...	...	...	?	...	...	...	...	*Pliocene ?*, Terrains Tertiaires supérieurs, Germany, (= *F. antiqua* and Auvergne species,) Giebel, Fauna der Vorwelt, t. i. p. 35.
—— catus	...	...	...	...	...	...	...	...	...	*Caverns*, Owen, Brit. Foss. Mamm. and Birds, p. 172; (= *F. ferus*,) Marcel de Serres, Cavernes de Lunel-Viel, p. 119; Gervais, Zool. et Pal. Fr. p. 229.
—— pardoides	...	...	...	...	×	...	...	...	...	*Pliocene*, Red Crag, Suffolk, Owen, Brit. Foss. Mammalia, p. 169.

	A.	D.	C.	PL.	P.	M.	E.	CR.	O.	
Felis spelæa		×	×							*Caverns*, Europe, GOLDFUSS and SOEMMERING, Nov. Act. Nat. Cur. t. ix. p. 476, pl. 65, ex. pl. 45 PICTET, Paléontologie, p. 228; Atlas, pl. 5, fig. 9; (= Lion,) MARCEL DE SERRES, DUBREUIL, and JEAN-JEAN, Cavernes de Lunel-Viel, pp. 101 and 107; BLAINVILLE, Ostéographie, " Felis," p. 101; GERVAIS, Zool. et Pal. Fr. p. 123; GIEBEL, in Neues Jahrb. 1849, p. 65; LEIBNITZ, Protogæa. pl. 11, fig. 1; CUVIER, Extrait d'un ouvrage sur les Ossements quadrupèdes, p. 7 (1802); ROSENMÜLLER, —— ?; CUVIER, Oss. Foss. vol. iv. pl. 32, fig. 3, 4, 6, 7, pl. 36, fig. 1, 2, 3; BUCKLAND, Rel. Dil. pl. 6, fig. 6; *Caverns*, Kirkdale and Plymouth, pl. 22, fig. 6; M'ENERY, Desc. Kent's Cavern, pl. C, fig. 1; *Caverns*, Liége, SCHMERLING, *op. cit.* pl. 15, 18; *Caverne* de Goffontaine, BLAINVILLE, p. 104; *Alluvium*, Rue Hauteville, Paris, CUVIER, Oss. Foss. vol. iv. p. 456; and BLAINVILLE, Ostéog. " Carnassiers," p. 105; PANDER and D'ALTON, Skelett. tab. viii. fig. *a*; and Raubthiere, pl. 8, fig. *a*, *b*, *c*, *d*; SCHMERLING, Cav. de Liége, p. 72, pl. 14, 15, 16, 17.
—— antiqua			×							*Caverns ?*, Europe ?, CUVIER, Ossem. Foss. 4th edit. t. iv. p. 499, pl. 36; (= Chat très-voisin du Léopard;) *Diluvium*, *Caverns*, and *Osseous Breccia* of the Mediterranean, MARCEL DE SERRES, *op. cit.* p. 115; GERVAIS, Zool. et Pal. Fr. p. 124; BLAINVILLE, Ostéographie, " Felis," p. 121; Val d' Arno, NESTI, in letter to Prof. Savi, 1826; TARGIONE ?; Auvergne, CROIZET and JOBERT; *Caverns*, Liége, SCHMERLING, pl. 18, fig. 7–9; *Cavern*, Engihoul, pl. 18, fig. 17–22.
—— (*leo ?*)										*Caverns*, (= *F. spelæa*, PICTET, p. 229,) Lunel-Viel; M. DE SERRES, p. 112, pl. 7, fig. 4–7, pl. 8, fig. 15.
—— sp.										—— ? —— ?; (= larger but like the Serval,) MARCEL DE SERRES, *op. cit.* p. 92; PICTET, Paléont. Pal. p. 229.
—— sp. ...		×								*Diluvium*, Osseous Breccia, Nice, PICTET, Paléontologie, p. 229.
—— Engihouliensis			×							*Caverns*, Belgium, (= near the Lynx,) SCHMERLING, Cav. de Liège.
—— cristata						×				*Miocene ?*, Sivalik Hills, India, CAUTLEY and FALCONER, Asiatic Researches, vol. xix. 1st part, p. 135 (1836), pl. 21; Ann. des Sc. Nat. ser. 2, t. xi. p. 128.
—— protopanther			o							*Caverns*, Brazil, LUND, Ann. des Sc. Nat. ser. 2, t. xi. p. 232, and t. xiii. p. 32.
—— onca ?			o							*Caverns*, Brazil, LUND, (= form of Jaguar, but larger,) *op. cit.* pl. 18, fig. 4–6; Germany (1831), MOTT, Man. de Pétrifactions, p. 32.
—— sp.			o							*Caverns*, Brazil, LUND, *op. cit.* pl. 18.
—— sp.			o							*Caverns*, Brazil, (= Conguar in form and size,) LUND, *op. cit.*; PICTET, Paléont. p. 229.
—— sp. ?			o							*Caverns*, Brazil, PR. MAX, Voyage au Brésil ?; LUND, Mem. Acad. Sc. Copenhagen, vol. viii. p. 91, pl. 18, fig. 1–3 (1841); (= *Felis macroura*,) BLAINVILLE, Ostéog. p. 149.
—— exilis			o							*Caverns*, Brazil, LUND, *op. cit.*
—— sp.			o							*Caverns*, Brazil, (= ? *Cynailurus* or Guepard,) LUND, *op. cit.*; BLAINVILLE, Ostéographie, " Felis," p. 145; PICTET, Paléont. p. 230.
Machairodus brevidens						×				*Miocene*, Terrains Miocènes inférieurs, Auvergne, POMEL, Bull. Soc. Géol. ser. 2, t. iii. p. 366; PICTET, Paléont. p. 230; Atlas, pl. 5, fig. 10, 11; (= *Steneodon*,) CROIZET, —— ?; (= *Megantereon*,) CROIZET, —— ?; (= *Cultridens*,) CROIZET, —— ?; (= *Drepanodon*,) NESTI, —— ?

FOSSIL MAMMALIA—*continued.*

× European area. † N. American. o S. American. * African. ‡ Asiatic. § Australasian.

Species.	Alluvial.	Diluvial.	Caverns.	Pleistocene.	Pliocene.	Miocene.	Eocene.	Cretaceous.	Oolitic.	Localities, Authorities, and References.
Machairodus palmidens						×				*Miocene*, Sansan, Blainville, Ostéographie, p. 157, pl. 17; (= *Felis megantereon*,) Lartet (*non* Croizet), Notice sur la Colline de Sansan, p. 19; Pictet, Paléontologie, p. 230.
—— sp.						×				*Miocene*, Eppelsheim; (= *Felis machairodus*,) Pomel, Bull. Soc. Géol. ser. 2, t. iii. p. 366; (= *M. cultridens*,) Kaup, Ossem. Foss. de Darmstadt, t. ii. p. 24, pl. 1, fig. 5; Pictet, Paléontologie, p. 230.
—— cultridens					×					*Pliocene*, Terrains Pliocènes, Auvergne, (= *Felis cultridens*,) Bravard, Monog. de deux Felis, p. 141; Blainville, Ostéographie, "Felis," p. 129, pl. 17; (? = *Machairodus megantereon; Felis megantereon*, Bravard and Blainville;) Pictet, Paléontologie, p. 230; (= sp.) Pomel, Bull. Soc. Géol. Fr. 1842, p. 29, pl. 1; (not sp.) Gervais, Zool. et Pal. Fr. p. 231; Val d'Arno, (= *Ursus cultridens*,) Cuvier, Ossem. Foss. 4th edit. t. v. p. 516; Kaup, Oss. Foss. de Darmstadt, p. 24, pl. 1, fig. 5.
—— Sainzelli?					×					*Pliocene*, Pliocène du Puy, Vialette, Aymard, communication inédite; Pictet, Paléontologie, p. 231.
—— maritima					×					*Pliocene*, Marine sands, Montpellier, Gervais, Zool. et Pal. Fr. explic. pl. 30; Pictet, Paléontologie, p. 231.
—— latidens			×							*Caverns*, Kent's Hole, Torquay, Owen, Brit. Foss. Mammal. p. 179; (= *Felis cultridens* d'Angleterre,) Blainville, Ostéographie, "Felis," pl. 17, p. 142; *Diluvium* du Puy, Gervais, Zool. et Pal. Fr. p. 126; Pictet, Paléontologie, p. 231.
—— neogæus			×							*Caverns*, Brazil, with *Megalonyx*, (= *Hyæna neogæa*, and *Smilodon neogæa*,) Lund, Mém. Acad. Copenh. 1842, t. ix. p. 121; Ann. Sc. Nat. ser. 2, t. xi. p. 224, t. xiii. p. 312, etc.; (= *Machairodus*,) Owen, Report Brit. Assoc. 1846; Pictet, Paléontologie, p. 224, and p. 231; (= *Felis smilodon*,) Blainville, Ostéographie, "Felis," pl. 20.
Pseudælurus quadridentatus						×				*Miocene*, Sansan, Gervais, Zool. et Pal. Fr. explic. pl. 30; (= dent carnassière supérieure de la Panthère de Sansan,) Blainville, Ostéographie, "Felis," p. 155; Pictet, Paléontologie, p. 231.
II. AMPHIBIOUS CARNIVORA.										
Phoca vitulina?		×								*Diluvium?* Brick earth, Strathcden, Fifeshire; Page, Advanced Text Book of Geology (1859), p. 307. (? = tooth of *Calecephalus vitulinus*, Coll. Phillibert, *Pliocene* marine deposit, Poussan, near Montpellier, Gervais, Zool. et Pal. Fr. p. 140.)

	A.	D.	C.	PL.	P.	M.	E.	CR.	O.	
Phoca (*fossilis*)	...	...	...	...	...	...	...	...	...	Cuvier, Ossem. Foss, 4th edit. t. viii. p. 452 ; (= *Halitherium, vide*) Pictet, Paléontologie, p. 232.
? —— sp.	...	...	..	...	...	...	...	...	...	*Cretaceous*, Terrain crétacé supérieur, Boué, Journal de Géologie, t. iii. p. 31 ; (= ?) Pictet, Paléontologie, p. 232.
—— Viennensis	...	...	...	...	...	×	...	...	...	*Miocene*, Holich, valley of Danube, near Vienna, (= *P. Viennensis antiqua*,) Blainville, Ostéographie, "Phoques," pp. 42, 51, pl. 10.
—— sp.	...	...	...	...	...	×	...	...	...	*Miocene ?*, deposit unknown, (lower canine,), (like Otarie,) Gervais, Zool. et Pal. Fr. p. 140 ; Pictet, Paléontologie, p. 232 ; Atlas, pl. 8, fig. 8.
—— sp.	...	...	...	...	...	×	...	...	...	*Miocene*, Faluns de Romans, Drôme, (upper incisor like *Stenorhynchus*,) Gervais, *op. cit.* p. 140 ; Pictet, Paléont. pl. 20, fig. 5, 6.
—— sp.	...	...	...	...	...	×	...	...	...	*Miocene*, Grès marins de Leognan, Gervais, *op. cit.* p. 140 ; (= doubtful lower canine of perhaps Dolphin,) Pictet, Paléontologie, pl. 41, fig. 1.
—— ambigua	...	...	...	...	×	...	...	...	...	*Pliocene ?*, Marnes Tertiaires d'Osnabrück, H. v. Meyer, Graf zu Münster, Beitr. zur Petref. t. iii. p. 1, pl. 7 ; Pictet, Paléontologie, p. 223, pl. 6, fig. 1, 3.
—— rugidens	...	...	...	...	×	...	...	...	...	*Pliocene ?*, Tertiaire de Neudorf, H. v. Meyer, Neues Jahrb. 1845, p. 309 ; Pictet, Paléontologie, p. 233.
—— occitana	...	...	...	...	×	...	...	...	...	*Pliocene*, Terrains Pliocènes, Montpellier, Gervais, Zool. et Pal. Fr. pl. 8, fig. 7, p. 140 ; Pictet, Paléontologie, p. 233.
—— sp.	...	...	...	...	×	...	...	...	...	*Pliocene*, Terrains Pliocènes, Montpellier ; (= like common Seal, but larger,) Gervais, Zool. et Pal. Fr. pl. 8, fig. 7, p. 140 ; Pictet, Paléontologie, p. 233.
—— proboscidea	...	...	...	...	×	...	...	...	...	*Pliocene ?*, Tertiary schists, the Martha-Vineyard, America, Lyell, Lond. Edin. and Dubl. Phil. Mag. 1843, t. xxvi. p. 187 ; (= recent *P. proboscidea*,) Owen, —— ? ; Pictet, Paléontologie, p. 233.
Pachyodon mirabilis ?	...	...	...	...	×	...	...	...	...	*Pliocene ?*, Tertiaire de Moeszkirch, H. v. Meyer, Neues Jahrb. 1838, p. 414 ; (= ?) Pictet, Paléontologie, p. 233.
Trichechus sp.	...	...	...	...	...	...	...	...	...	*Pliocene ?*, Turf Marshes, Russia, shores of Kamtchatka ; Georgi, Hist. Nat. Russ. vol. iii. p. 591, *vide* 'Geologist' (1863), vol. vi. p. 248 ; near Angers, Cuvier, Ossem. Foss. 4th edit. t. viii. 1, p. 458 ; Blainville, Ostéographie ?, p. 43 ; Pictet, Paléontologie, p. 233.
—— sp.	...	...	...	...	×	...	...	...	...	*Pliocene ?*, Dax, Département des Landes, Cuvier, *op. cit.* p. 458 ; Pictet, *op. cit.* p. 233.
—— sp.	...	..	...	...	×	...	...	...	...	*Pliocene ?*, Terrain Tertiaire, Virginia, Mitchell, Smith, and Cooper, Ann. of the Lyceum of New York, t. ii. p. 271 ; Harlan, Phys. and Med. Res. p. 277 ; Edinburgh New Philos. Journ. 1834, t. xvii. p. 360.
										[The head found by Monti at Bologna, De Monumento Diluviano, 1719 ; (= *Rhinoceros, vide*) Pictet, Paléontologie, p. 234.]
										[*Trichechus molassicus*, Jaeger, Säug. Würt. p. 200 ; (= Sirenoïde, *fide*) Pictet, Paléontologie, p. 234. See also Zimmermann, Neues Jahrb. 1845, p. 73 ; Owen, Proceed. Geol. Soc. 1843, vol. iv. p. 283.]

Fossil Trichechus.—"The teeth of the sea-horse are frequently found in many places of the Arctic turf-marshes bordering on the Frozen Sea, and they are so fresh that they are sold in commerce for ivory. In the Gulf of Penschin there was one of these teeth dug out that was 8½ lbs. in weight, and another in Kamtchatka weighing 5½ lbs. (*P. Nordmann*, Beytr.) A tooth of a bluish colour was found at the mouth of the Tagil." —Extract from Georgi, (Nat. Hist. Russia) 'Beschreibung des Russischen Reichs,' vol. iii. p. 591, by S. J. M.

Salt Deposit at New Iberia.—The rock-salt at this place in Louisiana is of the most extensive and wonderful description, and of great purity. One American account says:—"Imagine the granite quarry of Massachusetts, or the marble quarry of Vermont, to be solid deposits of pure rock-salt, clear and transparent as so much clear white ice in one solid inexhaustible mass underlying the earth, and you will then acquire an imperfect idea of the vastness of this salt formation."

Natural Formation of Carbonate of Soda.—In the 'Pharmaceutical Journal' for July, Dr. Haines, of Grant College, Bombay, gives an account of the natural production of carbonate of soda in the neighbourhood of Aden. It occurs in the form of irregular, colourless, partly crystalline masses, apparently of two distinct portions: one a brilliant, confusedly crystalline mass, amongst which the angles of cubical crystals could be observed; the other, a white amorphous substance, of a greasy feel and soapy odour, very similar to crude borax. By analysis, the composition was given as:—

Neutral carbonate of soda	51·05
Common salt, with traces of sulphate of soda and chloride of magnesium	21·94
Water and organic matter	19·66
Sand	4·35
	100·00

Captain Playfair, Assistant Political Resident at Aden, states that this substance is found all along the coast to the east of Aden to an extent of perhaps ten miles, and its quantity is practically unlimited. It is usually found in hollows behind (or beyond) high-water mark to which the sea-water has access by percolation. There is no demand for it at present, but some months ago, sixty to seventy camel-loads a day were brought into Aden, and met with a ready sale at 2½ rupees per ten maunds (equal to two shillings a hundredweight). The only use made of it is to mix with snuff, to increase the pungency; rarely, too, it is used for washing clothes. It is variously called by the Arabs *Dukduka*, *Hurka*, and *Kára*.

From the valuable paper published by Mr. H. J. Carter in the Transactions of the Bombay Branch of the Royal Asiatic Society, on the Geology of Arabia, it appears that the whole of the south-east coast of Arabia, from Rus-al-Had to Bab-ul-Mandib, is capped with nummulitic limestone, pierced at frequent intervals with basaltic effusions, and in many places elevated so as to form lofty and abrupt cliffs, in which, beneath the limestone, other formations are visible. As a result of this formation, the shingle on the coast consists mainly of limestone; and although no specific description of the coast immediately to the east of Aden has been given, there is no reason to doubt that the same peculiarities prevail there. It is then to the percolation of sea-water through a stratum of fragments of limestone that we must attribute the production of the carbonate of soda, by which percolation, probably, a partial interchange of elements has been effected between the chloride of sodium and the carbonate of lime, giving rise to the formation of chloride of calcium and carbonate of soda. It has been long suspected that the natural production of carbonate of soda was dependent on the presence of carbonate of lime, and was brought about somewhat in this way; but what the conditions are under which the separation of the carbonate of soda from the chloride of calcium is effected, without allowing the former to exert its ordinary converse action upon the lime-salt and reproducing carbonate of lime, is a question that would form a very interesting subject of scientific inquiry. This is, I believe, the first time that the natural production of alkali from sea-water itself, without organic agency, has been observed.

It is hardly probable that the production of carbonate of soda in this way is limited to a few miles' distance from Aden. As the shore is so very similar along the whole 1125 miles which form the south-east coast of Arabia, there is a reasonable expectation of finding it at many places elsewhere; and an article so much in request, so easily procured, and with water-carriage close at hand, might yield a fair amount of profit to an enterprising shipper who should collect or purchase it upon the spot.

LAKE SUPERIOR SILVER.—The silver found at Lake Superior is native, and is the most extraordinary metallurgical paradox yet discovered, in which nature has shown that she can completely surpass art. It is found in large quantities in the native copper mines of that district. The combinations of the silver with the copper present most varied forms; in some instances the native silver is found running through a mass of native copper in veins of varied thickness, like veins in marble; at other times it is found attached to masses of copper, in many beautiful floriated forms of a large size and sometimes resembling the stumps of old trees, and frequently covering the whole surface of a mass of copper on all its sides to a considerable thickness, and presenting most beautiful forms in cubes, prisms, and four-sided pyramids, which appear as though the whole mass of copper had been thickly electrotyped with the precious metal. Its varied forms and its extreme purity, although in conjunction with the copper, renders it a subject of the greatest curiosity, both metals having been, some think, subjected to a heat that must have been equal to a refiner's smelting-heat, and yet the metals are each found in perfect purity. In all the mass of copper of this vast district, silver is associated with it to a greater or less degree, but not in sufficient quantity to pay for its separation. The rock in which the silver of this district most abounds is an amygdaloidal trap of a very compact nature. The miners of this district for many years considered the native silver as a perquisite,—as they used to say they were employed to mine for copper and not for silver; therefore the proprietors rarely used to get the silver, but the miners always had an abundance. This state of things now no longer exists, and the proprietors get a large share of this valuable production.

In a contribution to the 'Washoe Times,' Mr. J. B. Truckee states that he had the most valuable collection from the Superior mines in Europe, which he was solicited by the commissioners for mines and minerals to place in the Paris Exhibition as an illustration of the productions of the mines of Lake Superior, they undertaking to return the collection intact when the Exhibition closed; but at the time when he looked for its return, he was waited upon by two gentlemen, who came from the Emperor of France, to request that the collection might remain at the School of Mines in Paris. As Mr. Truckee considered this school the first of its class, he consented to his collection remaining there.

In this collection there are crystals of pure native copper in clusters of perfect cubes, to which are attached floriated native silver.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society.—*June* 17*th*.—1. "On the Relations of the Cromarty Sandstones containing Reptilian Footprints." By the Rev. George Gordon, LL.D., and the Rev. J. M. Joass. With an Introduction by Sir R. I. Murchison.

In the introduction Sir R. I. Murchison gave a sketch of the geology of the Tarbatness promontory, which is composed of variously coloured sandstones, having a conformable dip to the N.W. In these strata the authors had found footprints (of animals believed to be Reptiles) similar to those found in the sandstones on the coast of Elgin; and it was therefore desirable to prove whether these rocks really belonged to the Palæozoic series, or, as some geologists suppose with regard to the Elgin sandstones, to the Trias. In order to solve this problem, if possible, the Rev. Mr. Joass made a careful survey of the coast from Geanies to Tarbatness Lighthouse, and round along the north shore of the promontory to the inlet at Inver, and found a conformable succession between the undoubted Old Red Sandstone of Geanies and the track-bearing sandstone of Tarbatness.

The Rev. Dr. Gordon gave a description of the various tracks; the smaller kind are referred by him to an unknown Crustacean; the larger and more definite impressions, however, he considered to be the footsteps of some kind of reptile. He also stated, as confirmatory of the "Old Red" age of the beds, that the Oolitic beds of Shandwick are unconformable to the Old Red Sandstone.

2. "On some Tertiary Shells from Jamaica." By J. Carrick Moore, Esq. With a Note on the Corals, by P. Martin Duncan, M.B. London; and a Notice of some Foraminifera, by Professor T. Rupert Jones.

An examination of seventy-one species of Tertiary Mollusca from Jamaica, mostly collected by the late Mr. Barrett, showed that twelve are still living, and that twenty-eight are common to the Tertiary beds of Jamaica and St. Domingo. The same relation between those deposits had been found to exist by Dr. Duncan through a comparison of the corals. The "Pacific" affinity of many of these shells and corals was noticed as confirmatory of a conclusion arrived at by the author in a former paper; and it was shown, from the occurrence of Tertiary beds on the Panama Isthmus at a height of 250 feet above the sea, that the complete separation of the Atlantic and Pacific Oceans did not take place until after the commencement of the Tertiary period. The distribution and affinities of the Nummulina and Orbitoides were described by Professor Jones, and those of the Corals by Dr. Duncan.

3. "On the Geology and Mineralogy of a part of Borneo." By M. Cornelius de Groot.

A collection of specimens from Borneo and Java, presented by the author to the Museum of Practical Geology, was accompanied by some explanatory notes, in which it was stated that the steam-coal of Borneo underlies the Nummulitic formation, and probably belongs to the "Étage Suessonien" of D'Orbigny. The occurrence of tin in steam-works, and as veins in granite, at several places in the western portion of Borneo and the islands of Blitong and Banka, was particularly described, as well as the presence of ores of copper and manganese. Some Tertiary fossils from Borneo and Java were also noticed.

4. "Description of a new Fossil Thecidium from the Miocene Beds of Malta." By J. Denis Macdonald, Esq.

Amongst the many fossils occurring in the lower part of the Calcareous

Sandstone of Malta is a small Thecidium, nearly allied to *T. Mediterranea*, but much smaller than that species, and, on close inspection, having other and very decided specific distinctions. Mr. Macdonald gave a detailed description and figures of this new species, and proposed for it the name of *Thecidium Adamsii.*

5. "On the Sandstones and Shales of the Oolites of Scarborough, with descriptions of new Species of Fossil Plants." By J. Leckenby, Esq.

The true position of the well-known plant-bed at Gristhorpe Bay, below the grey limestone, was first pointed out by Professor Williamson, and afterwards by Dr. Wright; and Mr. Leckenby showed that all the plants hitherto referred to the Upper Sandstone, Shale, and Coal, belong to the Lower Sandstones and shales, but few plants having been found in the true Upper Sandstones and shales overlying the grey limestone. The author gave lists of fossil plants occurring in the two sets of strata, as well as of those occurring at the separate localities; and he concluded by describing some new and some imperfectly known species of Ferns.

6. "A Monograph of the Ammonites of the Cambridge Greensand." By H. Seeley, Esq.

The excavations in the Upper Greensand of Cambridge have furnished Mr. Seeley with an opportunity of examining a great number of specimens of the different species of Ammonites occurring in that formation, and he now communicated the results of his examinations to the Society, giving detailed descriptions of the species.

7. "On a new Crustacean from the Glasgow Coal-field." By J. W. Salter, Esq.

In a previous paper the author collected together what was known of the Macrurous Crustaceans of the British Coal-fields; since then, Mr. James Russell has discovered a new species, remarkable on account of the antennules being larger than the antennæ, and which Mr. Salter now described in detail.

8. "On the Occurrence of a Bituminous Substance near Mountgerald, Scotland." By Dr. G. Anderson.

The section exposed by some deep cuttings for the Ross-shire Railway, two miles north of Dingwall, exhibits a grey, micaceous, and almost horizontal conglomerate, traversed by fissures containing a black bituminous substance, which the author stated might have infiltrated down from a bed of bituminous schist which apparently overlies the conglomerate.

9. "On the Occurrence of Albertite at Mountgerald, Scotland." By A. C. Mackenzie, Esq.

In making a drain on a farm near Mountgerald, a fissure was discovered which contained a bituminous substance very similar to the Albertite of New Brunswick; a deposit of a similar nature was also discovered in making a cutting through "The Crag," near Mountgerald. The author described the stratigraphical and lithological characters of the rocks met with in making this cutting, and stated that as many as thirty-six veins containing this mineral were passed through.

10. "On the Occurrence of Rocks of Upper Cretaceous Age in Eastern Bengal." By Dr. T. Oldham.

During the years 1851–52, the author examined the rocks of the Khasi Hills, in Eastern Bengal, and made a collection of the fossils occurring there. These fossils were mostly from a Nummulitic Limestone, and were evidently of Eocene date; but some were obtained from a sandstone underlying this limestone, and appeared to be of Cretaceous rather than

Tertiary age. Unfortunately they were lost during their transmission to England; but the author gave a list of genera and of some species since obtained.

Manchester Geological Society.—*June* 30*th*.—Mr. Joseph Goodwin presented to the Society two specimens of shale; one from the Jet Amber Mine, Haughton, containing minute shells of Anthracosia, and the other from the Peacock Mine, Hyde, containing beautiful specimens of ferns (Pecopteris), etc. A vote of thanks was passed to Mr. Goodwin for his donation.

A collection of fossil fishes, consisting of Megalichthys, Helodus, etc., from the roof of the Spanish Juice or Half-yard Mine at Carr Knol, near Oldham, was presented by Mr. John Butterworth, of Moorside, Oldham. Mr. Wilde, of Moor Edge, sent for exhibition a fossil plant found in the sandstone at Oldham Edge, which he thinks proves that Halonia is but the root of Lepidodendron This connection of the two plants, Mr. J. S. Dawes, F.G.S., of Smethwick House, asserted he had proved many years since.

The paper read was " On the Effect produced on Rowley Rag by Heat, and the practical Application of its Products to useful Purposes," by Mr. J. Plant.

The author's object was to give an opportunity for the examination of a series of specimens which were obtained from Mr. Henry Adcock, the inventor and patentee of the Basaltic Stone Works at Oldbury, Worcestershire; these works, and nearly all similar works for the conversion of basalts and vitreous slags to ornamental purposes, having been discontinued, opportunities will consequently rarely occur for the examination of the interesting results of these experiments.

The question as to the changes which heat has effected in the constitution and crystallization of certain igneous rocks has ever been one of great interest to the geologist; and with a view to explain certain theories upon the columnar structure and prismatic form of basalt, as observed generally, but more especially at the Giant's Causeway, Staffa, and the hill at Rowley Regis, experiments were conducted as early as the year 1804, by Mr. Gregory Watt; which experiments established the fact that basalt and trap were igneous rocks, and that the columnar structure of basalts could be experimentally produced under certain conditions of heat and pressure. Rowley Rag has been described by Senft as Melaphyre, an indistinctly mixed rock, intermediate between ordinary greenstone and black basalt, of dirty greenish-brown, hard and tough in a fresh state, having a specific gravity of 2·85, and a composition of silica, 55; alumina, 25; oxides of iron and manganese, 12; lime, 8; soda, 6; and inappreciable amounts of potash and magnesia. Mr. Watt fused 700 cwt. of this material, and kept it in a furnace several days after the fire was lowered. It fused into a dark-coloured mass, of a vitreous character, with less heat than was necessary to melt iron; and a portion which was taken out whilst the mass was in fusion, and cooled quickly, became perfectly glassy. As refrigeration proceeded in the mass it became changed into a stony substance, and globules appeared; these enlarged till they pressed laterally against each other, and became converted into polygonal prisms. The most important result observed was the formation of spheroids, sometimes extending to a diameter of two inches. They were radiated with distinct fibres, in somewhat concentric layers; but the centres of most of the spheroids became perfectly compact before they attained the diameter of half an inch. This structure gradually pervaded the whole body of the spheroid. A continuation of the temperature speedily induced another change; the texture of the cooling material became more granular, its colour more grey, and the brilliant points larger and more numerous. These brilliant molecules arranged themselves in regular forms, and finally the whole mass became pervaded with thin crystalline laminæ. Mr. Watt applied these facts in explanation of the globular structure which is observed in decomposing basaltic rocks; but as similar experiments have been often repeated, the results are familiarly known to every geologist, and need not be further alluded to in this paper. Sir James Hall, in 1805, conducted experiments illustrating the crystalline arrangements and texture assumed by basaltic rocks when fused and cooled under high pressure. He established the fact that most rocks of presumed igneous origin, when fused, yielded different products according to the differences in the amount of pressure under which they were cooled. Thus, when the rate of cooling was rapid, they formed a black amorphous glass; and when the cooling was slow, a strong mass with a granular structure. The same materials yielded the most dissimilar products,—a fact that is of the greatest importance in reference to the study of the nature of eruptive rocks, and of the metamorphic action which they occasion. These discoveries were chiefly valuable from their philosophical bearing upon contested points in the science of geology; and it was not until the year 1846 that any attempt was made to turn them to a practical and economical value. At that time, acting upon the results of some experiments which had been made upon the Continent, a Mr. Jean Michel Borgognon took out a patent in England for the manufacture of articles of utility in what he termed artificial basaltic lavas. His invention claimed the discovery of operating upon stony substances, but chiefly upon the vitreous slags from iron furnaces. These were fused at a high temperature, and run into moulds of cast-iron or refractory clay, the moulds being heated in the interior by means of a powerful flame, kept up by a blast. Colouring matter, from the oxides of iron and other metals, was mixed with the fused materials, and great diversity and beauty was thereby obtained in the vitreous ornaments. It does not appear, however, that any great application of his patented lavas was made in England. In the year 1851 Mr. Henry Adcock, a civil engineer, of Oldbury, took out the first patent for the production of bricks, tiles, pipes, etc., from the fused trap of Rowley Regis. This gentleman had been led to the application of this material from experiments which he had commenced in the year 1834. He then fused some Rowley Rag in a common kitchen-fire; and being much impressed with the beauty of the black glass as it fell on the hearth, he perceived that it might probably possess great practical value. He obtained the use of a reverberating furnace, and conducted his experiments upon a larger scale. In 1851 a patent was obtained, in which the inventor claimed for his discovery the melting the stony material known as Basaltic Trap, Rowley Rag, or Whinstone, and running the same when in a fluid state into moulds. The materials were heated in a reverberating furnace, either at the bottom or in crucibles, and then cast into cast-iron moulds put together with iron cramps. The fused trap was run into the moulds, when both were brought into a state of white heat. If it were intended to give a polished surface to the casting, the cast-iron mould was highly polished and coated with plumbago, also highly polished. If the fused materials were allowed to cool at a gradual and slow rate of cooling, the result was a hard stony rock, scarcely to be distinguished from the original trap from Rowley Regis; but a less degree of heat, with a quicker rate of cooling, caused the materials to assume the appearance of a mixed marble;

and a rapid rate of cooling produced a black glassy substance, quite opaque, unless it was cast very thin, and then it became semi-transparent. If it were desired to run the fused materials more quickly, a flux, such as soda, effected such a result. The practical utility of this invention became widely known, and an extensive application of it was made in ornaments of an architectural character, mantelpieces, window-sills, window-heads, string courses, capitals of columns, and monumental slabs, which were all cast from Rowley Rag; and these, from the almost imperishable nature of the material, are likely to endure for ages. For reasons which it is not necessary to state, the works did not long continue, and have since been taken down. In 1852 Mr. W. G. Elliott, Blisworth, took out a patent for the manufacture of pipes and other articles from mixed brick clay, limestone, ironstone, and oyster-shells. The product was a greenish-black vitreous material when run into press-moulds and afterwards annealed. There is very little difference between this application and that of Mr. Borgognon, and it added nothing which was not well known in the effects of heat upon minerals. In 1854 a patent was taken by Mr. J. T. Chance, of Birmingham, claiming improvements in the manufacture of articles from the mineral called Rowley Rag, in which the principal discovery, in addition to what had been known of its fusibility and of its adaptation for casting in moulds, was, that the fused mineral, unlike cast-iron, was capable of being rolled or pressed into the form of slabs, sheets, bars, and rods, all either with plain or raised ornamental surfaces. In fact, it could be treated in the same manner as plate-glass and some of the ductile metals; but articles manufactured in this way required to be subjected to the process of annealing. Another discovery was made about this time, in which it was shown that it was possible to mix a quantity of coloured glass with the fused Rowley Rag, for the specific gravity of basalt and common glass, when in a state of fusion, are nearly alike, and advantage was taken of this to produce sheets of the material which, when polished, resemble the rich and beautifully-coloured serpentines of Cornwall. In fact, there was no limit to the variety which could have been obtained by the admixture of these two and other substances,—the only point of any scientific interest in the matter being that the two materials did not chemically combine, even with the greatest amount of care and skill. They were only mechanically mixed together, and the result is well shown in the specimens upon the table. In 1855 Mr. Chance and Mr. Adcock took out a further patent for improvements in casting articles from the slags of iron furnaces, but this chiefly related to the machinery and method of casting in sand moulds in place of the iron moulds first used by Mr. Borgognon; and since this date no further discoveries appear to have been made in the practical application of the basalts and traps for economic purposes, or in the aid of the decorative arts.

The specimens exhibited by the author, in illustration of his paper, were obtained from Mr. Adcock, the inventor and proprietor of the Basaltic Stone Works, at Oldbury, Worcestershire, after the works were discontinued; namely, Rowley Rag in its natural state; a shining opaque glass—artificial obsidian—the common result of the Rowley Rag when cooled very quickly; specimen showing the conchoidal fracture, which is common to the fused as well as to the natural state of the Rowley Rag; specimens showing different amounts of recrystallization in accordance with the rates of cooling (in one the greatest degree of change ever obtained was shown, other than its entire conversion into basaltic stone); a specimen showing that in some instances the recrystallization takes place in bands; a casting of part of an ornament, exhibiting its perfect reconversion to the Rowley Rag; a specimen broken from a large mass of the recrystallized basalt; specimen resembling a natural vesiculated lava (when fused the Rowley Rag is very viscid, therefore, if a piece of wood, coal, or any other substance which will give off gas be plunged into it, the escaping gas will produce this vesiculated structure); specimens from the bottom of the furnace, in which the quartz gravel lining the furnace has become embedded in the melted lava (these are very similar to the toadstones and amygdaloid porphyries frequently met with in basaltic districts); a portion of the congealed coating which is instantaneously formed in the ladle used in pouring the melted matter into the mould (this is very similar to the crust which is observed on flowing lava from a volcano, and in a great measure preserves the under mass from cooling quickly; it was turned to advantage in casting, as the fused basalt would remain for more than an hour in the ladle when thus coated, and experience taught the workman that fused metal so retained made castings of a superior character; when a ladle was once coated to the thickness of half an inch it gained comparatively little in thickness, even when refilled three or four times); polished specimens of Mr. Chance's rolling of the obsidian glass from $\frac{1}{8}$ of an inch to $\frac{3}{4}$ thick, used as a substitute for roofing slates, Bath tiles, and inlaid work for halls (these sheets were rolled 8 feet long by 3 feet 8 inches, and were readily cut into lengths with a glazier's diamond; some were coloured by a mixture of glass; one had a design engraved upon the polished surface by means of fluoric acid, showing its adaptability for this character of decoration; one had a large percentage of glass and was coloured by a metallic oxide); artificial obsidian, cast in a cold iron mould; another specimen cast in a heated iron mould; part of an obsidian pipe, cast in a heated iron mould; another pipe cast in a damp sand mould; a hollow column, 6 feet high, 7 inches diameter (1 inch thick of this resisted a pressure of 300 tons; a pipe 4 inches in the bore and $\frac{1}{2}$ an inch thick resisted an hydraulic pressure of 220 pounds); artificial obsidian, with fine conchoidal fracture; three specimens of artificial obsidian.

Signor Berruti, of the Royal Geological Survey of Italy, said that in the course of his geological researches he had been in different volcanic districts where rocks occurred resembling the specimens on the table; he had had frequent opportunities of examining streams of lava which showed all the varieties of texture from compact basalt to those of obsidian and pumice. What he had seen made him quite agree with the views expressed in Mr. Plant's paper. In the neighbourhood of a volcano might be seen rocks of considerable thickness which at the top consisted of obsidian or volcanic glass, lower down the texture was of a duller and more earthy or stony character, and lower still, where the mass must have been a long time in cooling, it was very similar to basalt or Rowley Rag, being hard and of a sub-crystalline texture. It appeared quite clear that parts of the same mass of lava became a compact, stone-like basalt when cooled slowly, and other parts, when cooled rapidly, became obsidian; for near Naples a stream of lava, which had flowed into the sea, was converted into obsidian where it had been immersed in the water and quickly cooled; whereas, on the land, where the lava had cooled slowly, it had become more crystalline and approximated in texture to basalt,—the material being evidently similar in both instances. In Italy an attempt had been made to turn it to some use, and to a certain extent the experiments had been attended with success. At the same time it was not yet considered that the success was complete. He did not consider that the moulded ornaments manufactured from fused basalt had a tendency to decay or become decomposed by exposure to the atmosphere. He believed they would be found very durable when used in buildings. Mr. Atkinson asked if in the section of a bed of lava, for instance of the depth of 15 or 20 feet (or of the height of this room), the lowest portion which had sustained the greatest pressure, or the part which had been longest in cooling, ever assumed a crystalline structure similar to granite? Signor Berruti replied that the material was more compact, and showed traces of crystalline structure, but the crystallization was very different from that of granite.

Mr. Hull said if there was one question more than another we might consider absolutely settled in geology—though some geologists deny that anything at all has been settled—it is that these different varieties of trap, passing from greenstone and basalt into obsidian, are the result of differences in the rate of cooling under pressure. But when we come to the question with regard to granite, there, at once, we perceive a distinction. There is something very different and distinct between granite and lavas and other trap rocks. The great question is, why there should be such a distinction. We all know that granite is a highly crystalline rock, and the reason that we failed in making any approach towards forming granite by artificial processes of cooling is that we are attempting to do, on a small scale, what nature does on an enormous one, and with overwhelming forces and length of time, in her own laboratory. We can make no approach to the enormous pressure that nature has been able to employ during the cooling of the granite; nor can we lengthen out the time which granite has taken to cool within the bowels of the earth. It is now known by clear observations, some of which have been made in Dartmoor and other parts, that granite is nothing else but the melted stratified rock, passing sometimes into slate rocks; and so gradual is this passage, that it is sometimes difficult to say where one form of rock commences and the other ends. This shows us that granite is the result of metamorphism of the stratified rock at an enormous depth, in all probability when the rock was overlaid by many thousands of feet of strata, which have been since removed. Thus, in Devonshire, in the case of the granite of Dartmoor, the bosses of granite which appear there lie in the very strike of the beds, and occupy the place of certain members of the slate-rocks of that district. Nothing could better prove that granite is a highly-metamorphosed form of stratified rocks. The President, Mr. Dickinson, remarked that Mr. Hull has told us about the numerous points which have been settled in geology, and that if there is any one which is settled it is this one. He had now been a long time engaged in pursuits which have given him very great opportunities for observing the geological structure of the earth. In the course of those opportunities he had examined rocks similar to those exhibited to-day, both in Northumberland, Cumberland, Durham, Westmoreland, Cornwall, Devonshire, North Wales, and in many portions of Scotland, at the Giant's Causeway and Fair Head, in Ireland, also in the south of France, in Saxony, and in the Hartz Mountains, and other places; and as the result of his observations he was prepared to admit that the fusing of these rocks does give results similar to those that are occasionally found in nature; but with regard to the origin he was disposed to think geologists have settled far too much, and will have to unsettle a good deal of what they have decided upon. The way in which many of the trap rocks are found blended with the slates, etc., was to his mind a point of difficulty to be got over before we can recognise them as being formed by igneous action. The way in which what are called the floating whins of Scotland are found interspersed with the coal-measures lying in a semi-stratified slate, and which are supposed to have emanated from a chimney and overspread the coal-measures, has caused them to be quoted as of igneous origin. For himself he had never met with a chimney, nor with any person who had seen one. He had sunk shafts through these trap or basalt rocks, and had seen no difference as he proceeded downwards. There has been uniform structure throughout. He had also made many experiments with them; and he found generally there is a difference in what is obtained after melting, there being on the whole a more glassy structure obtained. The variation of the crystalline structure which Mr. Plant had pointed out was certainly very interesting, but it may possibly be accounted for otherwise than by the manner of cooling. He knew that the structure of certain metals became varied by different processes of cooling, and that certain metals when mixed together become crystallized sooner than others, and have a tendency when cooling to form aggregations; and upon this beautiful law is founded Pattinson's method of extracting silver from lead. By analysis he had found out that when there is a granular structure of the scoriæ from the blast furnaces of iron works, they generally contain more iron than those which have a glassy structure, and by this structure he could tell to within one or two per cent. how much of iron the cinder contained. He thought under all the circumstances we should do wisely to regard facts and observations simply as such, without being too hasty in jumping to conclusions. The scoriæ and remains of volcanos are different from trap rock.

Another paper, "On the Liberation and Drainage of Gases from Coal-Mines," by Mr. Joseph Goodwin, was read.

MISCELLANEOUS NOTICES.

The Fifteenth Annual Report of the Regents of the University of New York on the Condition of the State Cabinet of Natural History and the Historical and Antiquarian Collection annexed thereto (Albany, 1862), by Professor Hall, has the merits of conciseness, one page sufficing to state all that is wanted to be given on the general state of affairs. In the other portion of this report, which more immediately concerns us, it is stated, some of the results of Professor Hall's investigations in palæontology are communicated in anticipation of the publication of the volumes on the Natural History of the State. The species described by Professor Hall are:—

GASTEROPODA—*Platyceras subrectum, P. attenuatum, P. concavum, P. conicum, P. thetis, P. erectum, P. carinatum, P. Bucculentum, P. symmetricum, P. rictum, P. cymbium, P. fornicatum, P. crassum, P. ammon, P. dumosum, P. echinatum, P. argo, Platyostoma lineata, Pl. strophus, Strophostylus unica, Pleurotomaria arata, P. lucina, P. doris, P. unisulcata, P. lineata, P. capillaria, P. trilix, P. sulcomarginata, P. rotalia, P. euomphaloides, Cyclonema Hamiltonæ, C. lirata, C. multira, Macrocheilus Hebe, M. Hamiltoniæ, M. macrostomus, Murchisonia desiderata, M. turricula, Loxonema solida, L. ? subattenuata, L. robusta, L. Delphicola, L. Hamiltonæ, Euomphalus clymenioides, E. laxus, E. Eboracensis, Bellerophon curvilineatus, B. pelops, B. acutilira, B. patulus, B. rudis, B. leda, B. lyra, B. otsego, E. thalia, Phragmostoma natator, Cyrtolites pileolus, C. ? mitella, Theca ligea, Conularia undulata.* CEPHALOPODA—

Clymenia complanata, *C. erata*, *Trochoceras discoideum*, *Gyroceras trivolvis*, *G. Matheri*, *G. undulatum*, *G. nereus*, *G. eryx*, *G. cyclops*, *G. nais*, *G. (Cyrtoceras ?) spinosum*, *Cyrtoceras eugenium*, *C. jason*, *C. morsum*, *C. metula*, *Aploceras (Cyrtoceras) liratum*, *Gomphoceras beta*, *Orthoceras pelops*, *O. tetricum*, *O. foliatum*, *O. baculum*, *O. thoas*, *O. hyas*, *O. multicinctum*, *O. profundum*, *O. subulatum*, *O. constrictum*, *O. exile*, *O. crotalum*, *O. nuntium*, *O. perelegans ?*, *O. ægea.* Crustacea—*Calymene platys*, *Dalmania anchiops* and var. *armata*, *D. selenurus*, *D. ægeria*, *D. coronata*, *D. macrops*, *D. adspectans*, *D. myrmecophorus*, *D. helena*, *D. calypso*, *D. pleione*, *D. erina*, *D. bifida*, *D. Boothii*, *Homalonotus Dekayi*, *Phacops bufo*, *P. rana*, *P. cristata*, *P. bombifrons*, *P. cacapona*, *Proetus Conradi*, *P. angustifrons*, *P. hesione*, *P. clarus*, *P. crassimarginatus*, *P. canaliculatus*, *P. Vernuelli*, *P. Haldemani*, *P. Rowi*, *P. marginalis*, *P. macrocephalus*, *P. auriculatus*, *P. occidens*, *P. longicaudatus*, *Lichas armatus*, *L. grandis*, *Acidaspis* sp., *Beyrichia punctulifera*, *Leperditia cayuga*, *L. spinulifera*, *L. seneca.* Annelida—*Spirorbis angulatus.* Crinoidea—*Ediocrinus pyriformis*, *Cheirocrinus clarus*, *Ancyocrinus bulbosus*, *A. spinosus*, *Platycrinus eriensis*, *P. eboraceus*, *Poteriocrinus nassa*, *P. nycteus*, *C. diffusus*, *P. nureus*, *P. verticillus*, *P. indentus*, *Cyathocrinus bulbosus*, *Forbesiocrinus lobatus*, *F. nuntius*, *Rhodocrinus s. g. Acanthocrinus ? nodulosus*, *A. gracilis*, *Rh. spinosus*, *Trematocrinus spinigerus*, *Actinocrinus nyssa*, *A. eucharis*, *A. præcursor*, *A. cauliculus*, *A. calypso*, *A. pocillum*, *A. s. g. Megistocrinus depressus*, *M. ontario*, *Cacabocrinus speciosus*, *C. Troosti*, *C. liratus*, *C. liratus* var. *multilira*, *C. glyptus*, and var. *intermedius*, *C. lamellosus*, *Myrtillocrinus ? americanus*, *Haplocrinus clio*, *Nucleocrinus elegans*, *N. lucina*, and var. *N. Verneuli*, *Pentremites læda*, *P. calyce*, *P. Maia*, *P. Whitei*, *P. Lycorias*, *Eleutherocrinus Whitfieldi*, *Codaster pyramidatus.* Brachiopoda—*Zygospira* (new genus founded on *Atrypa modesta*), *Meristella* (new genus founded on *Atrypa quadricosta*), and *A. mesacostalis*, *Lingula tigea*, *L. palæformis*, *L. exilis*, *Discina alleghania*, *Crania Hamiltoniæ*, *C. crenistriata*, *C. Leoni*, *Onthis lepidus*, *O. cyclas*, *O. penelope*, *O. leucosia*, *O. solitaria*, *Orthisina arctostriata*, *Or. alternata*, *Ambocælia gregaria*, *Vitulina pustulosa*, *Spirifer venustus*, *Trematospira gibbosa*, *Rhynchospira nobilis*, *Rh. lepida*, *Atrypa pseudomarginalis*, *Merista Haskini*, *M. Barrisi*, *M. doris*, *M. multicosta*, *M. limitaris*, *M. quadricostata*, *M. mesacostalis.*

Professor Hall appends an amendment of the description of his genus Pholidops, and throws some doubts to the *Gonialites Patersoni* figured in the State Report, p. 99, belonging to the Hamilton shales, recent evidence indicating that it may be a Portage fossil. Eleven plates of figures are given.

In the January number of the 'American Journal of Science,' Professor A. Winchell enters the list in respect to the subject brought under discussion by Colonel Jewett's letter in November last, namely, the identification of the Cattskill Red Sandstone group with the Chemung. "No one who has recognized the carboniferous aspect of the fauna of the Marshall group of Michigan, with its equivalents in the West, can," he says, "feel any surprise at the announcement;" and he adds the following results of his own investigation during the past eighteen months:—"Species common to Michigan and Rockford, Indiana, 7; to Michigan and Burlington, Iowa, 7; to the three localities, 3; to Rockford and Missouri, 6; to Burlington and Ohio, 2; to Burlington and New York, 3; besides an almost universal identification establishing fully the equivalency of the Chemung, Marshall, Ohio, Rockford, Burlington, and Chanteau strata." "The evidences," he continues, "that these localities are all of Carboniferous age, are—first, the fact that of the 135 species now known from the yellow sandstones of Burlington, no less than 40 ascend into the base of the Burlington limestone, while 2 rise to the upper portion of it, and 1 recurs in the coal-measures; second, the fact that of the known species of this horizon at least 9 occur in the coal-measures or upper part of the Carboniferous limestone; while thirdly, multitudes of species are clearly representatives of European and American Carboniferous types."

The other geological articles in the January number, are:—"Exposition of the true nature of *Pleurodictyum problematicum*," and "On Mr. Hall's genus Leptocælia," by Carl Rominger, M.D.; "On the Actæonidæ," by F. B. Meek; "On Tellurbismuth, from Dahlonega, Georgia," by D. M. Balch; "On Octahedral Galena, from Lebanon County, Pennsylvania," by Dr. Torrey.

The March number opens with an able article by Mr. T. Sterry Hunt, of the Canadian Survey, "Contributions to the Chemical and Geological History of Bitumens and of Pyroschists or Bituminous Shales." Some of the facts and deductions given in it have already appeared in Mr. Hunt's "Notes on the History of Petroleum," printed in the 'Canadian Naturalist and Geologist' for July, 1861, and in the report of the Smithsonian Institution for 1862. Previous to the publication of these papers, Mr. Hunt had, in March, 1861, in his lecture before the Board of Arts, maintained that the source of the Petroleum of the West, was not as was generally thought. The May number we noticed at p. 276.

The interesting town of Manilla has been overthrown, almost in a moment, by an earthquake. Some accounts speak of the whole town being in ruins: others say that half the place has been destroyed. At all events, the Cathedral, the Royal Chapel, St. Domingo, St. Isabel, San Juan de Dios, the Palace, several schools, the military hospital, the buildings occupied by the Tribunal of Commerce, and indeed all the public buildings were razed to the ground; and even those buildings which remain are mostly so shaken that they must be pulled down. All the houses in Baracca fell. The Binonda, an ancient structure, was destroyed. The only church that has escaped entirely is San Augustin, which also withstood the tremendous shock of 1645. An architect's report, after a minute investigation of the peculiarities of the design and construction of this edifice, would be an interesting and instructive one. The Rodrigues property, left to the British nation, and where the British Consulate was, has been completely destroyed. About 1000 persons have been killed, and many thousands wounded. The survivors have mostly fled from the city, as many of the remaining buildings threaten a sudden fall, even though no repetition of earthquake should occur. The 3rd of June was the date of the catastrophe.

Professor Whitney, the State geologist of California, is reported to have found on the Sierra Nevada, at about 200 feet above the sea, the jaw of a rhinoceros.

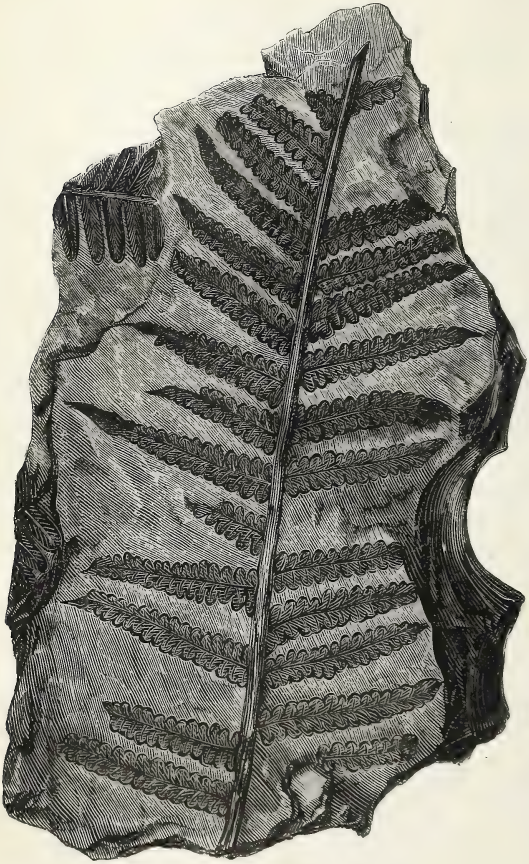
REVIEWS.

The Mines of South Australia.

Observing the growing importance of the mining interest in South Australia, and the evident want of general and correct information respecting its mineral resources, Mr. J. B. Austen, of Adelaide, conceived the idea of making a tour of all the mines in that colony, and of publishing the result of his observations.

Up to the close of the past year, 1720 mining claims had been applied for, and of these, 1576 within the last three years. The large majority of these represent 80 acres of land for each claim, and when the claim is taken up, a rent of ten shillings per acre is paid to the Government under the present regulations; the leases being for 14 years, and renewable at the end of the term on payment of a fine. But, although so many claims have been applied for, the number of mines actually worked is very small in proportion, the explanation of which is, that every claim does not represent a separate lode or discovery of mineral, but that when a discovery is made by one party, others take out claims all round in the hope of finding something, and often without any knowledge of the locality at all on the part of such speculators.

Where speculations are so ready, it will create no surprise that as soon as the least surface-indications can be shown, the spot is termed a mine, and some assumed or honorary "captain" writes a glowing report of the wonderful discovery, which of course, it is asserted, will pay from the very first day that a pick is struck into the ground. The experience of South Australian mining does not warrant a belief in these confident assurances, and it does not follow that even rich superficial indications will result in the development of a valuable mine; and Mr. Austen suggests the propriety, in cases of mineral property intended to be sold, of sinking one or two shafts or cross-cuts to prove the existence at least of an ore-bearing lode going down to the depth of a few fathoms. It is certainly fair for all parties that some amount of work should be done to prove a mine before it is sold, for if one of great worth might be sold by a poor or ignorant man for a very small sum, so might a higher price be given for a worthless mine. Concise and instructive, and, as far as a stranger to the country can judge, correct and fair accounts are given of all the mines in actual work. These are the Kapunda, Karkulto, Burra-Burra, Princess Royal, Bon Accord, Broughton, Mount Remarkable, Spring Creek, Great Gladstone, Kanyaka, Mount Craig, Wirrawilka, Kirwan, Napoleon, Wheal Blinmany, Davison's Claims, Wheal Butler, Mount Huro, Mount Rose, Apex Hill, Yadanamutana, Wheal Austen, Yelda, Pindilpena, Welcome, Oorooldana, Parabarana, Sir Dominutt, Daly, Wheal Frost, Mount Lyndhurst, Wheal Besley, Mochatoona, Wirryoota, Mount Stuart, Nuccaleena, The Two Brothers, Oratunga, Mooroo, Mount Chambers, Vesey's Claim, Mallee Hut Claim, Aroona, Welpena Pound, M'Conville's, Malone's Bremer, Preamimma, Kanmantoo, West Kanmantoo, Wheal Ellen, Monster Lode, Strathalbyn Montacute, Glen Osmond, Scott's Creek, Burritt, Gorge, Yattagolinga, Campbell's Creek, Falisker, North Rhine, Wallaroo, New Cornwall, Matta Matta, Kurilla, Duryea, Yelta, Moonta, Karkarilla, Wheal Stuart, Wheal Humby. After the accounts of the mines are descriptions of the smelting-works, mineral regulations, railways, and prices of labour and provisions are given. Altogether this must be a most useful book in the colony and out of it, and it would be well if the mines of our own country were noticed as fairly, in a similarly concise manner, by some of our able mineralogists.



SPHENOPTERIS FLAVICANS, Sternberg.

From Coal Shale, Forest of Dean ?

THE GEOLOGIST.

OCTOBER 1863.

FERNS IN COAL-SHALES.

By the Editor.

It is very much to be regretted that amongst our rising geologists we have none who are turning, as far as we know, their attention devotedly to fossil plants. There is a wide field open, and a most interesting one, for since the time of Lindley and Hutton, now six-and-twenty years ago, we have had no important British work on this branch of geology, and it cannot be supposed that the advance made by recent botanists in that interval would not be applicable, and of the highest advantage to the study of fossil vegetable remains. We have quite enough shell-pickers and mammoth-hunters for a few to devote their time and their energies to the ancient "flowers of the fields," if flowers there were in those dreary days which some of our *savants* picture when they tell us how the carboniferous vegetation luxuriated in the warmest and densest of fogs, and the earth itself was a gigantic warming-pan for the plants that grew upon it.

The pretty fern-leaf we have figured came into our possession some years ago very accidentally, so much so that we are not quite sure of even its locality, and it is now deposited in the National Collection. Neither in Lindley and Hutton, the figures in which are not exquisite examples of art, nor amongst the actual specimens in the British Museum cabinets, could we find anything with which it seemed to accord. In Sternberg's 'Flora der Vorwelt' there appeared to be, in plate xxxviii. fig. 1, *a*, *b*, *c*, a fern presenting the same configuration of leaflet and the like venation, and, without doubt, we think the species is the same, namely, *Sphenopteris flavicans* of Presl. Not finding this species recorded as a British one, we carefully drew it; but our engraver, not being a naturalist, has lost the character of the venation in endeavouring, to his mind, to improve the picturesqueness of the drawing. The Plate (XIX.) however gives a very good idea of the general form, while the two little outlines of the venation we have added make up for the trifling damage the engraver unwittingly committed.

The description given by Sternberg is,—

> S. fronde bipinnata, pinnis alternis sessilibus multijugis, pinnulis alternis subsessilibus parallelis lineari-oblongis obtusis profunde pinnatifidis basi acutis, laciniis oblongis obtusissimis integerrimis, venis pinnatis simplicibus apice acuto libero ante marginem frondis evanescentibus, costis rachibusque convexis flexuosis.
>
> *S. flavicans*, Presl.
>
> In schisto lithantracum Bohemiæ ad Brzas, prope Radnitz. Color frondis uti videtur amplæ griseo-flavescens vel flavescente-virescens. Figura 1*a* ectypum a figura 1*b* paululum differens exhibere videtur; differentia hæc inde exorta esse potest, quod in figura 1*a* frondis pars suprema, in 1*b* frondis inferior fere pars unius ejusdemque stirpis conservata esse videtur. In figura 1*c* pinnula aucta exhibetur.

It is deeply to be regretted that the many opportunities that are hourly occurring in this land of coal and iron are so thoroughly neglected, and that scarcely anywhere, except in the Manchester district, are any collections of coal-plants made. Mr. Binney has done more in this way than any one else; but necessarily, from his other and important business avocations, his scientific studies would be somewhat desultory.

It is a common practice now to speak of coal being formed of certain kinds of plants, whose remains have been found in the shales associated with the coal-seams; but surely much false reasoning may thus arise, and the difficulties of such a line of argument become painfully evident when palæontologists speak of the old coal-making forest-trees as growing like mangroves in the sea. In the shales and other strata associated with our coal-beds we have land-insects and sea-shells. We do not usually nowadays find the like associations in our tropical forests or in our own verdant dells. Surely it is ra-

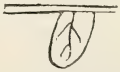


Fig. 1. Venation of British Specimen figured in Pl. XIX.

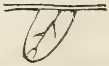


Fig. 2. Venation of Sternberg's specimen—*Sphenopteris flavicans.*

ther more likely that the shales represent intermediate and different conditions happening between each formation of coal; and, in this case, the ferns imbedded in the shales may have belonged to quite another class of vegetation from that which formed the coal. Has anybody ever thought sufficiently how far the tender herbs of those days and myriads of fallen seeds might have been the chief sources of that bituminous product which makes England the first country in the world for civilization and wealth?

It is not our intention now to enter, however, into the matter of the formation of coal, nor of the nature and characters of the many beautiful vegetable forms which are imbedded in the intercalating strata. But we wish some one would earnestly take up the work.

CORRESPONDENCE.

The Older Parian in Trinidad.

Dear Sir,—Permit me to observe, in reply to Mr. Lankester (whose letter appeared in your issue of July), that I am not the authority for the correlation of the Older Parian formation in South America and Trinidad, with the Neocomian of Europe. Indeed, from the references I gave I should have thought that Mr. Lankester would have had no great difficulty in finding out that the supposed age of the formation in question rested upon far better evidence than any I could produce. I had it only in my power to add a little to the evidence already accumulated on the subject, and to demonstrate it almost to a certainty that the rocks at Pointe-à-Pierre in Trinidad do belong to the same formation which it was the opinion of the Government Geological Survey that they did; that is, to the formation at Cumana, containing *Trigonia subcrenulata*. The opinion of the Government geologists was built upon evidence which was none the worse for being strengthened; and I had it in my power to do so.

But if the references given in the footnotes to my paper are not sufficient, I beg to refer Mr. Lankester to those appended to Mr. Wall's paper on the geology of Venezuela and Trinidad (Quart. Journ. Geol. Soc., vol. xvi. p. 465). Von Buch's work on the fossils collected by Humboldt contains much evidence relating to the age of the formation in South America.

When I transmitted my paper to you I was perfectly aware of Professor Huxley's views as regards "homotaxis;" and I have held opinions of a somewhat similar kind for some time previously to reading Professor Huxley's able address to the Geological Society. But in writing my paper on the Older Parian formation, my object was not to support or elucidate any theory which is yet quite new and unacknowledged by geologists at large; more especially when it did not make the least difference one way or the other as to the question upon which I was engaged. Whether the rocks in South America containing organic remains of types similar to the Neocomian of Europe were actually contemporaneous with the latter formation, or merely homotaxical and representative of it, was not the question I proposed to deal with. The general sequence of animal life is admittedly the same in either case; and whether the Neocomian in South America was or was not contemporaneous with the Neocomian in Europe, still it would have to be considered in comparative geology as Neocomian, at all events until some better nomenclature could be decided on. If Belemnites are not found above the Chalk, in Europe, it is probable they will not be found above the homotaxical representatives in South America of the Chalk.

I trust that this explanation will prove satisfactory to Mr. Lankester and to those of your readers who may take an interest in the matter.

I am, Sir, your obedient servant,
R. Lechmere Guppy.

Port of Spain, Trinidad, July 28th, 1863.

Former Higher Temperature of the Earth v. *Atmospheric Pressure.*

Sir,—The Rev. James Brodie, at the late British Association Meeting, stated that if at any time the earth had been subjected to a great increase of temperature, it necessarily implied an immense increase of pressure in the atmosphere. A slight increase, he said, would double the atmospheric pressure. Can you, Sir, inform me the grounds of the assertion, and the reasons why the atmospheric pressure would be augmented by the increase of internal heat? Perhaps Mr. Brodie would condescend to enlighten myself and others of your readers who may be in the same ignorance as myself upon this very interesting subject, if you, Sir, cannot or decline to give us the explanation.

Yours respectfully,
Pulex.

Taunton, 4th September, 1863.

BRITISH ASSOCIATION MEETING AT NEWCASTLE.

The Section of Geology was under the Presidency of Mr. Warington W. Smyth.

President's Address.—If there is any one part of the British Islands where the very name of the place is naturally associated in our minds with a particular geological formation, it is the town of Newcastle as associated with coal; and, beyond a doubt, many of the present visitors to this cradle and centre of the coal trade will have made their journey hither with the expectation of not only hearing communications on various branches of geological science, but more especially of adding something to their knowledge of the carboniferous strata. We are to be favoured with several papers dealing with different portions of the subject, and it may be advisable that I should invite your attention to the state of our knowledge of the occurrence and history of the coal-measures generally, referring mainly to the phenomena which characterize that most valuable region in which we are assembled. I shall attempt, as it were, an overture giving a general outline of the carboniferous plot, and introducing a few notes to illustrate those passages which are most likely, in our successive acts, to demand attention and concentrate our interest. The carboniferous system is commonly divided, for convenience' sake, and in accordance with the structure of most European coal-fields, into three principal divisions, viz. the carboniferous limestone, the millstone grit, and the coal-measures. I need here say nothing of the Devonian or Old Red Sandstone system, or of the still older rocks, which in the absence of the Devonian form the foundation of that great division of the geological scale with which we are engaged. The Carboniferous or Mountain limestone, the oldest group of strata for our consideration, might be hastily passed over, but for its presenting in this northern district a transitional type between Scotland and the south of England, no less important in its commercial aspect than interesting to the geologist, in the various inquiries which it suggests. Turn to the Mendips, to Wales, or to Derbyshire, and we find the carboniferous limestone constituted almost exclusively of actual limestone-strata, amounting to from 300 or 400 to above 1500 feet in thickness, and never exhibiting other than the smallest traces of beds of coal. But in Yorkshire a change sets in: the carboniferous action, if I may so term it, applies the thin end of the wedge, and small seams of coal of but little value are intercalated amongst the beds of limestone, and associated with a large proportion of shale and sandstone stratified with a remarkable regularity. Advancing northward, these seams increase in number and importance through the great moorland region which culminates in Cross Fell, the same strata rising from far beneath our feet as we stand here on the Lower Tyne, emerge to the daylight and compose the substance of the Pennine chain, which, with its lofty and heather-purpled undulations, forms the broad dividing ridge of Northern England. In the region of Weardale and Aldstone, where, in the becks and burns and in the great escarpment which towers above the valley of Eden, excellent exposures of the strata invite our study, the shales are often very similar to those of the coal-measures, though containing but few vegetable remains; the sandstones and grey beds frequently exhibit stems and fragments of plants familiar to us in the overlying strata, and the coal-seams are *crow-coal* or anthracite, resting in a bed of indurated siliceous silt or clay. Northward, however, of the great fault which runs nearly parallel to, but south of, the Newcastle and Carlisle railway, the coal-seams become, and, as it appears, suddenly, bituminous, and the lower division of the limestone admits more numerous intercalations of shale, sandstone, and coal; and when we follow it to the upper district of the Tyne and beyond the river Coquet, the violent folding and contortion to which the strata have been subjected bring into view new basins or fields of coal. The true position of these is far beneath our ordinary measures, and has been recognized as such in Scotland, where they attain a vast importance. In the Berwick district, which has been minutely described by Mr. Boyd, it would appear that about 400 fathoms of carboniferous limestone measures have been detailed below the Whin Sill or Basaltic bed and about 100 fathoms above it, including in all twelve seams of coal of from 2 to 4 feet each. Certain of these, the Scremersten seams, appear to be remarkable in having a limestone roof. For the details of another of these basins of the limestone coals, I may refer you to an excellent paper by my indefatigable friend Mr. Nicholas Wood, published, as is Mr. Boyd's paper, in the Transactions of the Institute of Mining Engineers. Let us pass from the upper beds of the limestone to the next overlying group of deposits. The Millstone Grit, or "farewell rock," as it is sometimes called by colliers, embraces a series of strata unproductive in coal, and in which conglomerates and coarse and siliceous grits often preponderate. With this rugged crown many of the Fell tops are capped; but before it bends downwards to pass under the first strata of the coal-measures, we may frequently find with it strata of shale and sandstone and fire-clay, roughly similar to those of the true measures, but presenting to a practised eye peculiarities of structure and colour. As we descend eastward from the higher ground of the moorlands, on the edge of which the first Brockwell seam of coal is traced, and as we find new and higher seams constantly succeeding, and the strata inclined regularly towards the sea, we pass into the midst of that tract which, extending from the river Coquet on the north to near the Tees on the south, for 50 miles in length, forms the great northern coal-field. The greatest thickness attained by this formation is probably not more than 2000 feet; but it would be vain for me, within a limited time, to offer you details of the strata,—a subject which has been amply treated by Mr. Buddle, Mr. Wood, Mr. T. Y. Hall, Mr. Greenwell, and others. Let it suffice to say that in this thickness, there exist, associated with shales of many varieties and with fine-grained sandstones, some fifty-seven beds of coal, from an inch thick upwards, comprising in all 75 feet of coal; but that what are considered the workable seams are twelve in number, giving an aggregate of about 50 feet of coal. The most famous of these seams, from above downwards, are the high main, the yard coal, the "Bensham," "five-quarter," "low main," "lower five-quarter," "Ruler or Hutton seam," the "Towneley or Beaumont," the "Busty bank," "three-quarters," and the "Brockwell." On the east the coal-measures are overlaid, in a line running from South Shields past Houghton-le-Spring to near Bishop Auckland, by the Permian series, represented by the magnesian limestone and the Lower Red sand, that unequal and water-bearing bed which forms the great obstacle to the sinking of shafts to the underlying coals. Prejudice, it is well known, even after the difference of these strata from the mountain limestone was proved, long contended that the coal would not be found continuous beneath the magnesian limestone; and it is still asserted that the seams have proved inferior when they pass beneath it, as shown especially by the failure, in certain tracts, of the Five-quarter and Hutton seams. But no sufficient reason is apparent why such deterioration is not rather to be ascribed to that variation in quality which all seams are found to undergo when followed over a large area, than to the soil influence of an unconformable upper formation. The variation here alluded to exercises an important bearing on the commercial relations of different parts of the field, and whilst the best "household coal"—bright, giving a black cinder, and free from ash—extends from the Tyne to the Wear and from the last river to Castle Eden, and occupies another area about Bishop Auckland, the steam-coal, more dense and yielding a white ash, characterizes the district beginning some five miles north of the Tyne, and the tender-coal, best suited for coking, is largely worked all along the line of the western outcrops from Ryton down to the outskirts of Raby Park. As regards the physical agencies which have impressed its present form on this great coalfield, I would remark that they appear to have acted with upheaval in a north and south direction, as evinced by the regular strike over a great length of country. This was accompanied or followed by transverse fractures resulting in several very pronounced lines of fault. Two of these, running respectively E.N.E. and E.S.E., are the whin or basaltic dykes named the Hett and the Cockfield dykes. Of the others, the most noticeable is the great fault called the Ninety-fathom dyke, which starting from the coast near Cullercoats, where it displaces the strata to that amount, ranges past Gosforth to Blaydon, and then entering on the more hilly ground may be traced westward to the New Red Sandstone of the neighbourhood of Carlisle. Along this western part of its course its throw is so great, as to inlay, as it were, on its north side, in the midst of the limestone district, a long strip of the coal-measures of the Newcastle field, and thus to give rise to the collieries of Stublick, Midgeholme, Tindal Fell, etc. The coals and other strata of this field have sometimes been compared with those of Belgium ; but when we regard the decided east and west troughing and folding, and the vast number of the seams which are so noticeable in the latter, we may conclude more properly that it is in the peculiar and often similarly circumstanced coalfield of Somersetshire that we have to seek for the direct continuation of the field of the low countries. Let us now cast a brief glance on the theoretical side of the subject. Upon the mode of origination of the limestone, the shale, and the grit, little difference of opinion is now entertained. That the coal itself has been formed purely from vegetable matter can no longer be questioned. The view originally propounded by De Luc, that the vegetation now composing our coal-seams grew on the soil which actually forms the bed or "thill" of the seam, has met with very general acceptance, notwithstanding the difficulty of adopting it in certain exceptional cases. That this dense mass of vegetation swelled over an area frequently subjected to depression beneath the neighbouring waters admits of but little doubt. Such an hypothesis serves to explain not only the equable covering of the coals with their roofs of muddy or sandy matter; afterwards consolidated into shale and grit, and exhibiting to our gaze the remains of mullusca and fishes which tenanted the waters of those depressions, but indicates also the mode in which certain seams have been divided by partings almost imperceptible in one place, but amounting to many feet in another. The well-known Busty Bank seam of the western district, some 5 feet thick, including a clay band of 11 inches, is thus divided in a distance of 2 or 3 miles, by the increase of the parting to 18 feet, into the stone-coal and the Five-quarter at Garesfield Colliery. A still more remarkable instance is the Tow Law seam at these works, 6 feet 3 inches thick, which, by the increase of a parting as it goes eastward, exhibits at Bowden Close Colliery, only 3 miles away, two seams divided by no less than 16 fathoms of ground, in which beds of sandstone or pert and their seams of coal have been intercalated. Such partings, when composed of shale, are often one mass of stigmarian impressions, and thus form no exception to the generally important part which that fossil plays as the root of the chief plant of the coal; but when the partings consist of fine-grained clean sandstone, showing no trace of rootlets, I confess that the appearance of bright solid coal resting upon them seems to me to demand some other explanation. Instances of this kind observed in South Staffordshire and in the Whitehaven collieries, induce me to think that the material must in some cases have been introduced between the laminæ, and sometimes even diagonally athwart them, subsequently to the solidification of the coaly matter. But there are several curious phenomena as to which a doubt frequently arises, whether they are due to action during or after the formation of the coal, and deductions of no small practical importance sometimes depend on the question. Thus Mr. Hurst has given to the Institute a very exact account of irregularities, especially *swellies*, or narrow depressions in the Low Main coal, which appears to have been formed prior to the deposition of the upper seams. On the other hand, Mr. Marcus Scott has excellently described a broad valley of denudation which was eroded in the coals of the Shropshire field, and filled in with higher unproductive measures. Again, with some of the slips and faults or troubles we may sometimes observe both coal and ironstone beds so to change on approaching them, or to vary so much on opposite sides of them, that whilst in some few cases we may be led to suspect their contemporaneity with the beds themselves, there are many more which we cannot explain without supposing that the coal must at the time of the disruption have been moulded and squeezed in an almost plastic condition. In the determination of the plants of the coal much has been done, and the Newcastle names of Hutton and Witham have gained deserved honours in the cause. But much remains to be done by microscopic inquiry and by the observation in the pits of the plants which accompany particular seams. Göppert tells us of certain coals of Rhine-Prussia and Silesia that different seams are distinctly formed of different plants, sometimes Sigillaria and Lepidodendron, at others Coniferæ, and in many Stigmaria being chiefly prominent. May we not by degrees connect the peculiar and perhaps varying character of seams with the plants of which they are formed, and may we not advance to a much nearer perception of the true character of those wondrous primeval forests? And here I would remind you that whilst some of our guides in coal-geology incline to the opinion of a marine origin for their plants, thus bringing them into natural contact with the fishes and the probably marine shells often found in the shales, others insist on a terrestrial vegetation, and a third on that of lagoons or sea-swamps and bogs. The last few years have given more heavy arguments to those who insist on a lurid forest, however near to the water's level it may have been. We but recently knew that among these giant stems of Sigillaria the busy hum of flying insects and the merry chirp of the cricket were heard, that scorpions curled their ominous tails, that land shells crept slimily along, and that several genera and many species of reptiles either pursued their prey along the ground or climbed the trees, where hollow trunks have formed the casket to contain their remains. Here, then, is a goodly population to vivify the scene which only a few years ago was held to be almost wanting in all but vegetable life; and when we consider the accidents which have, amid the great decomposition of organic matter, preserved to us these remains, generally enclosed in ironstone nodules, we must feel confident that coming years will have many an additional fact to disclose. Of the whole range of the carboniferous formation, perhaps the most interesting in several respects is the lower division. Many years ago, Professor Phillips described the peculiar group of unquestionably marine shells occurring in the roof ot the Halifax coals; and my friend Mr. Binney has traced throughout the length of Lancashire several seams which are thus characterized, and which are invariably below the thick seams of the main coal-field. I have been greatly interested in hunting up the same group,—the well-known *Aviculo-pecten papyraceus*, *Goniatites Listeri*, *Orthoceras*, and *Lingula* —in Derbyshire, North Staffordshire, and in North Wales. Again, they occur very similarly in South Wales at Merthyr and Nant-y-glo, and further west in the Kilkenny coal-field. I have devoted, at intervals, several days to the search for them in this coal-field, but hitherto unsuccessfully; and whilst their occurrence lends great force to the probability of the original unity and the subterranean connection of most of our coal-fields, their apparent absence in the Durham and Cumberland lower coals appears to indicate a peculiar difference in the conditions of deposition. The identification of distant seams, and of low as compared with high measures, appeared on this evidence very feasible; but Mr. Hull has not long since shown that caution is still needed, by announcing the occurrence of the same group in a higher seam in Lancashire. It is well known that the ironstone bands are among the most prolific sources of the objects of these studies, and I must, in conclusion, refer to the very interesting lists and parallels of fossils prepared by Mr. Salter for the two last numbers of the 'Iron Ores of Great Britain,' in the memoirs of the Geological Survey. The rich stores obtained by zealous collectors in South Wales, and yielded by the productive strata of the Potteries' coal-field, have been formed under his careful hands into a very valuable foundation, upon which I hope that we may soon see in course of erection a systematic and comparative natural history of the British coal-fields.

ON COKE, COAL, AND COAL MINING IN NORTHUMBERLAND AND DURHAM. By Messrs. Wood, J. Taylor, and J. Marley.—The Northern Institute of Mining Engineers will publish this paper, with several illustrations.

ON THE FOSSIL TEETH OF HORSE FOUND IN RED CLAY AT STOCKTON. By Mr. J. Hogg.—As many human bones had been dug up in the same field, it was supposed that a battle had been fought there, and that horses and riders had been interred together.

MAGNESIAN LIMESTONE OF THE COUNTY OF DURHAM. By Messrs. Forster and J. Daglish.—As the magnesian limestone covered a considerable portion of the northern coal-field, its study was most interesting to those engaged in the mining operations of the district. This arose from its important bearing, not only in geological, but also in physical conditions. Of the latter, one of the most marked was the large quantity of water met with in shafts that had been sunk through the limestone for the purpose of winning the coal below. In all sinkings through magnesian limestone there were feeders of water, chiefly from gullets and fissures, and if the shaft were not drained the water rose to a point which generally remained constant. Although the line commenced at the sea-level, it neither continued in this plane nor followed the line of stratification nor the undulations of the surface, but rose almost uniformly with the surface as it passed inland. At Seaton Pit it is 226 feet from the surface, and at Hetton, 3½ miles directly west, it is 108 feet; and as the surface-level of the latter is 90 feet above that of the former, it follows that the line of saturation rises in this direction at the rate of 60 feet per mile. There is a curious anomaly in the case of North Seaton and Cambois Pits. The circumstances which favour the remarkable accumulation of water in the limestone, and the rapidity with which it is drained off into pits sunk through it, is due to several causes, some of which are peculiar to this formation, and perhaps to this district. They are—1st. The arrangement of the beds of stratification; 2nd. The contour of the country; 3rd. The permeability to water of this formation. The beds of stratification dip towards the sea at an angle somewhat more inclined than the surface of the ground, so that on this line of section the magnesian limestone crops out with a bold escarpment, about 3½ miles inland from the sea, forming one of the most pleasing features in the landscape of the south-east portion of Durham. An observer standing on the escarpment, and looking inland, would have an extended view over the wide expanse of flat country, which, owing to the softer character of the rocks of the coal-measures, always lies at its base, and ever running up into the limestone in deep bays or fiords, gives it the character of an ancient rugged coast-line. Seaward an entirely different aspect is presented, a series of undulating hills, intersected with many deeply-cut picturesque and beautiful ravines, which being low and sheltered are well wooded and clothed with a luxuriant foliage. The boldness of this escarpment is, no doubt, to a certain extent due to the soft nature of the "yellow sand" lying immediately below it; this sometimes reaching a thickness of 50 feet, extends over the flat base to a considerable extent beyond the limestone, and, being thoroughly pervious to water, forms a natural absorbent for all the drainage of the district round, which is further increased by the numerous before-mentioned bays jutting into the limestone. In addition to this, over the country extending from the outburst of the limestone to the sea, the large fissures already spoken of as intersecting in all directions the limestone form so many channels of communication between the surface and the bed of "yellow sand" down which the surface drainage, and even in some instances small streams, pass freely. It cannot therefore be wondered at that, when this formation is pierced by any shaft below the level of saturation, large volumes of water should be encountered; and, although this may for the time increase the engineering difficulties, and frequently add much to the cost of winning coal through the limestone, it has at the same time its brighter points of view, affording, as it does, an inexhaustible supply of pure and agreeable water to the inhabitants residing on its surface. The large towns of South Shields and Sunderland are entirely supplied by water pumped at extensive works at Cleadon, Fulwell, and Humbledon Hill. The town of Seaham Harbour is also similarly supplied. The water is hard for domestic purposes, but delightfully clear and refreshing to the taste." The general stratigraphical character of the magnesian limestone of the district was then entered upon. The next subject was the connection between the dislocation affecting the coal-measures and the magnesian limestone, this portion of the paper being illustrated by reference to a forty-feet upthrow fault, which passes through both the "Jane" and "Caroline" shafts of the Eppleton Hetton Colliery.

SKIDDAW-SLATE FOSSILS, AND HORNBLENDIC GREENSTONES AND THEIR RELATIONS TO THE METAMORPHIC AND SILURIAN ROCKS OF THE COUNTY OF TYRONE. By Professor Harkness.

NEW COAL-PLANTS FROM NOVA SCOTIA. By Dr. Dawson.—One of the plants, *L. Acadianus*, belonged to the genus *Lepidophloios* of Sternberg; the other was an example of a type of *Lepidodendron*, very characteristic, in Nova Scotia, of the lower coal-measures associated with the lower carboniferous limestone. The author concluded that the original species of Sternberg, *L. laricinum*, was founded on the fragment of the bark of an old trunk, having the leaf-bases flattened, and hence described as scales. It was evidently, in short, closely allied to the specimen described. The genus *Ulodendron* was, he thought, identical with *Lepidophloios*, but apparently founded on specimens having the leaf-bases preserved, with the cone scars, but wanting vascular scars. It appeared to him that the generic names Ulodendron, Lomatophloios, Leptoxylum, Pachyphlœus, and Bothrodendron should be abolished in favour of Lepidophloios, unless indeed it should appear that any of these names had priority in date. The second plant described was the *Lepidodendron corrugatum*, which was one of the most abundant in the lower coal-measures of Nova Scotia and New Brunswick. The species was remarkable for its variability, and also for the dissimilar appearances of old stems and branches occasioned by the separation of the areoles in the growth of the bark, instead of the areoles themselves increasing in size, as in some other Lepidodendra.

MODELS ILLUSTRATING THE CONTORTIONS IN MICA-SCHIST AND SLATE. By Mr. H. C. Sorby.—The models consisted simply of bands of india-rubber laid upon each other. In one, the alternate bands were covered with cloth, so as to deprive them of the elasticity possessed by pure india-rubber. The object of the models was to show how various phenomena in nature have probably been caused by lateral or superincumbent pressure. Pressing each end of a model with a little force, Mr. Sorby easily produced a series of curves and undulations, the suggestions of which were at once appreciated by the Section. In the case of the model with the alternate bands of varying flexure, the result was, of course, such as would be produced by contortions of alternating strata. Another effect was gained by having one end of a model held tightly and leaving the other free, so that, according to the pressure used and the curvature produced, the loose ends overlapped each other.

ON A DEPOSIT OF SULPHUR IN CORFU. By Professor Ansted.—The island of Corfu and the other Ionian Islands, as well as the adjacent mainland of Greece, consist almost entirely of limestone. A chain of limestone mountains, ranging east and west, crosses the island of Corfu at its northern extremity, and as this is transverse to the general direction of the mountains on the mainland, and also to the geographical axis of the island, it may be regarded as a spur rather than a principal range. Crossing the pass of Pantaleone, a few miles beyond we come to the village of Spagus, the walls of which are built of gypsum. In the pieces of gypsum it is not rare to find yellow markings and patches of native sulphur. Leaving Spagus, a path leads by a deep ravine to a small quarry about a mile and a half to the north-west. Probably about a mile further beyond the ravine a small cutting presented a section about 8 or 10 feet high, and perhaps 20 feet in length. Here simple quarrying operations had been carried on. From the surface to the bottom of the quarry there were bands of gypsum nearly horizontal, and between them, somewhat irregularly, bands of native sulphur, varying in thickness from a quarter of an inch to an inch or more. There were also large masses of sulphur not continuous. All the gypsum gave forth a strong sulphurous odour when tapped with the hammer. From this little opening he was told that five tons of sulphur had been removed and used in the neighbourhood for the vines. He was informed that below these seams there was another thicker, at somewhat greater depth, and that for a distance equivalent to five English miles towards the coast to the north and west, a similar deposit was known.

PORPHYRITIC ROCK OF CHARNWOOD FOREST. By Professor Ansted.—The part of England referred to is a small district in the county of Leicester, east of the various other developments of igneous rock in England. The object of this paper was to show that the rocks, consisting of syenites, granites, and others of the appearance and character generally regarded as igneous, were really of the same date as the slates with which they seem to alternate. The area concerned is only eight miles in length and not more than five miles across; but within that space it contains a singular variety of the rocks usually called igneous. For the sake of convenience the author called them porphyries, including all under that general name. They all contain nearly the same mineral composition. The slates are found disturbed by an antichinal axis, and are turned round at the southern extremity; but with that exception all dip in the same direction on both sides of the granites and syenites. There are also in many places very well marked alternations and passages by which the slates may be traced into granite. This perfect gradation is one of the geological characteristics of the district, and, combined with the extreme variety of rocks of the granitic kind, render the whole of Charnwood Forest typical in English geology. It is clear either that the slates were originally a continuous submarine deposit, of which certain parts have since become porphyries, or that the slates were formed from clay at successive intervals of time,—the time being long enough, and the change of level great enough, to admit of the conversion of clay into slate on each occasion, while each interval was also marked by the outpouring of igneous rock,—or else, that the slates were cracked in the plane of their bedding, and the granite thrust through without disturbing the dip.

These last two hypotheses are too little probable to require much consideration. On the whole, the author concludes that the theory of metamorphism is that which will ultimately commend itself to geologists.

The author disputed the propriety of attributing these slates and other rocks of Charnwood to the Cambrian period; all we knew was the fact of the great mass of them being clearly the result of some older condition of the earth. Professor Ansted concluded by pointing out that the existence of any fluid nucleus of the earth near the surface, or even within many hundred miles, is altogether contradicted by the latest physical investigations; that the existence of a few good instances of passage-beds from slate to granite is sufficient proof of the possibility of that metamorphosism of which there are so many other indications, and that the study of one small typical district like the one in question is of itself more instructive and useful to the geologist than larger illustrations, though these also must be obtained before he can arrive at any general conclusion.

THE ROCKS OF THE MALVERN HILLS. By Mr. H. E. Holl.—The author arrived at the following "conclusions:"—

1. That the metamorphic rocks of the Malverns are probably of Laurentian age. 2. That these Laurentian rocks were above the sea-level during the period of the deposition of the Cambrian system. 3. That previous to, or during the deposition of the Primoidal Zone, the range became depressed. 4. That subsequently to this the range was again elevated, and continued so until after the deposition of the Lower Llandovery rocks. 5. That the Upper Llandovery beds were deposited during a period of depression, which depression continued until after the deposition of the Middle Devonian series; that portion of the range which is between the Wind's Point and the Worcestershire Beacon having been the last to be depressed. 6. That subsequently to the Middle Devonian period the range again became elevated, and continued so during the deposition of the Upper Devonian beds, the carboniferous limestone and millstone grit. 7. That this was again followed by gradual depression, during which the coal-measures, the Permian system, the Trias and Lias, were deposited. 8. That the eruptions of trap-rock along the range of the Malverns belong to two distinct epochs, the one anterior, the other posterior to the deposition of the Upper Llandovery beds. 9. That the age of the faulting of the Upper Silurian and Devonian strata on the western flanks of the range, was after the close of the Middle Devonian period, and dependent on the upthrust of the crystalline rocks which took place about that time; but that the age of the great longitudinal fault, on the eastern side of the range, was subsequent to that of the Lias.

[Sir R. Murchison did not expect that he should live to see the day when these schists, and sandstones, and so forth, should be called Laurentian gneiss. He must protest, in the most energetic manner, against the application of this name to them.]

IRONSTONES IN THE WEST OF ENGLAND. By Mr. C. Moore.—The paper described in detail the equivalents of the Cleveland Hill ironstones in the West of England, commencing at Lyme Regis, and extending to Yeovil and Bath.

ON THE ORGANIC CONTENTS OF THE LEAD VEINS OF ALLENHEADS AND OTHER LEAD VEINS OF YORKSHIRE. By Mr. C. Moore.—The author thought he need scarcely remark to those who are acquainted with mining operations that the contents of mineral veins are often as varied in their character as they well can be, in general being highly mineralized and dense, at other times varying from a conglomeratic infilling to materials more nearly approaching the sands, marls, and clays of stratified deposits.

A close examination of the latter shows that at whatever depth they may be found they give evidences of their having been derived, some, probably, from the denudation of older rocks which have been re-deposited with their organic contents in the then open fissures of the veins, others from younger deposits showing that the rocks in which the veins are found were then either the bottom of the ocean or within its influence. That the deposit in the veins was at times very slow is shown by some of the clays being composed of as thin laminæ as if they had been deposited in horizontal beds. On having the specimens of the material before one, nothing can look more unpromising to the eye of a Palæontologist. The most sanguine would scarcely expect that anything like an extensive fauna could be derived from them, and yet he had before him probably from 160 to 170 species derived from carboniferous limestone veins alone. The first step in their discovery is to wash the vein-stuff, floating away as much as possible of the finer material; in doing which from some of the mines you cannot but be struck with the great beauty and variety of the tints that are produced, the water being coloured by the different specimens from the most delicate French white to the densest black. In the sediment remaining after the washing, the organic remains are to be sought for. So abundant are they in some instances that half an ounce in weight has yielded as many as 156 specimens, whilst others still remain in the deposit. Numerous though the organic remains may be, it is not to be expected that they are to be found in every sample selected somewhat promiscuously from a mine. Those that are mineralized or crystallized may be at once set aside as barren. Below are given the number of samples examined, and those that are fossiliferous:—White Mines, Cumberland, seven samples, organisms in two; Grassington Mines, Skipton, fifteen samples, organisms in six; Alston Moor, eleven samples, organisms in five; Weardale, twenty-seven samples, organisms in thirteen; from Allenheads, eight samples. These being much mineralized, organic remains were found in three samples only; but in six others that have been more recently sent and more carefully selected, organic remains have been found in every instance. The samples referred to above weighed from a pound to about an ounce. The lowest depth at the Allenhead Mines he had yet traced organisms is 678 feet, but there appears no reason whatever for supposing that they may not be obtained from the lowest workings, provided favourable material for examination can be obtained. He would now take the Alston Moor Mines of Cumberland. In specimens from the Slaggy Burn, Copper Hazle, we have a deposit of the same mineralogical condition, and containing precisely the same genera and species as those from Corrhaust, Weardale, and equally abundant. The same influences appear to have been at work at these points depositing a similar material with precisely the same organisms, and we thus have in effect what, if they had been found in a stratified bed, would be recognized as organic remains upon the same horizon. Returning again to the Yorkshire mines; in the Grassington Mines of Shipton, in No. 1, he found fragments of bone or fish-scale, and No. 4, which, before being washed, looked like a yellow brown marl, was wholly composed of encrinital stems. This came from 330 feet from the surface. But the most abundant organisms, and perhaps the most interesting of all, come from the New Rake Veins. A sample, weighing when washed only half an ounce, is crowded with fossils. A very singular group of specimens occurs here, which have been called *Conodonts* by Pander, who considered they belonged to fishes, and divided them into thirteen genera of fifty-six species; but lately they have been examined by Dr. Harley, who, from their microscopic structure, thinks they belong to crustacea. Those presenting the comb-like form of very minute fish jaws, he has called *astacoderma.* A remarkable form, figured in a diagram exhibited by the author, was surrounded by serrated edges, and by one or two ridges in the middle, looking in the enlarged form as much like a rat-trap as anything he could compare them to, had never before been observed. It is interesting to notice that hitherto these curious bodies have only been found in the Ludlow bone-bed and its foreign equivalents, but here we have them in the carboniferous limestone. They are associated with numerous minute spine-like bodies, which appear to have a structure allied to that of fishes. There are teeth of small fishes, and univalves of different species. From these facts it appears to the author clear that all the carboniferous limestone veins, as far as he had been able to examine them, have been within reach of the ocean, at periods which would be indicated by their organic contents, obtaining their materials at one time from the denudation of older deposits, at others from the precipitation into them of much younger ones. The latter he stated to be the case with those of the Mendip and South Wales, whilst in Yorkshire the presence of Silurian conodonts would appear to imply the former.

He had stated that identical organisms occur at certain depths at Alston Moor and Weardale, placing them probably on the same horizon. It might be a difficult matter for investigation, but he believed it possible, by a consideration of this question, that certain horizons in mines might be established, not so clearly, of course, as in stratified deposits, but such as might enable a mine-manager to know the position of veins relatively with mines in other neighbouring districts, and thus know whether he might, and at what distances, be passing into barren or paying ground. Further, he believed these investigations would assist to establish the fact that minerals are due, not to plutonic, but to the very opposite agency.

THE ORGANIC REMAINS OF THE NORTH STAFFORDSHIRE COALFIELD. —Mr. Mullins read a report of a committee on the distribution of the organic remains of the North Staffordshire coalfield. The report was a long and detailed description, and appended to it there were lists of fossils collected from sixty-eight distinct beds of coals and ironstones, or, including subordinate beds, upwards of a hundred. The total number of species was stated at from seventy-five to eighty, and of about thirty-five genera. In the majority of beds, both of coal and ironstone, the upper surface contains a substance resembling a bone, and the scales, teeth, and other parts of fish, which have, beyond all doubt, been subjected to the action of water. This line is often extended into the body of the ironstone, but in no instance has it been known to penetrate the body of the coal.

ON THE CHRONOLOGICAL VALUE OF THE LOWER TRIASSIC ROCKS OF DEVONSHIRE. By Mr. Wm. Pengelly, F.R.S.—The author stated that the red rocks of Devonshire were eminently detrital, consisting of conglomerates, sandstones, and marls, and belong to the Bunter or Lower Trias. They occupy the whole of the country east of a line from Torbay to Porlock, in West Somerset. The general dip is about 15½ degrees in the direction N. and 44½ degrees E. (true), so that, judging from this horizontal extension in this direction, their volume must be enormous. Having dwelt at some length on the proposition that the rate of sedimentation must be, on the whole, limited by that of the requisite previous denudation, he proceeded to show that the amount of deposited matter is not necessarily the *measure* of the denudation which has taken place, or of the time expended on it. Amongst other facts in this part of his paper, he noticed the occurrence of pebbles of Triassic *sandstone* in the Triassic *conglomerate*, of denudational inequalities in the superior surfaces of beds at various levels in the same vertical section, and of certain peculiar phenomena connected with the structure known as "diagonal stratification;" after which he proceeded to show that the conglomerates and sandstone, in every layer, afford evidence of their littoral origin, and of their having been deposited on a tidal strand undergoing slow subsidence; and concluded with a description of two systems of dykes of Triassic sandstone, one of which, having a north and south direction, invariably intersects the other, which runs nearly east and west.

On the Causes of Earthquakes and Volcanic Eruptions. By Mr. J. A. Davies.—The theory of the author was that these phenomena, generally preceded by atmospheric alterations unusual in degree, were also connected with them, and, indeed, caused by them. He imagined that the matter of volcanic eruptions, which, or part of which, might be the interior surface of the earth's crust rendered fluid by fusion, was constantly pressed against its solid parts by the repulsion of deeper-seated central heat, and that this pressure was balanced by the weight of the external atmosphere, the equilibrium being destroyed by the rarefaction or greater density of the air, combined with variations in the internal heat, and that thus these phenomena are produced.

The Chairman, Professor Harkness, remarked that the writer did not appear to be aware of the most recent observations of the highest authorities on the subject, and before a definite conclusion could be arrived at concerning the influences of atmospheric pressure, it was necessary that a greater number of observations should be made than had been made by Mr. Davies.

The Early Conditions of the Earth, by the Rev. Mr. Brodie, who maintained the following propositions:—1. The greater heat of the temperate and polar regions, in the earlier eras, cannot be accounted for on the supposition that the distribution of land and water was different from that which now exists. 2. The change which seems to have been produced on the metamorphic rocks was not caused by heat from within acting upon them while they were covered with a mass of superincumbent strata. 3. That we have no conclusive evidence that the temperature of the central part of the globe is higher than that of the surface. 4. That there is no evidence that the great mass of the earth has ever been in a fluid state. 5. That all the phenomena hitherto observed may be satisfactorily accounted for, on the supposition that the earth was at some former time exposed to great external heat. The general inference which he would deduce from his observations was that in all speculations in regard to the physical condition of the earth in former epochs, it should ever be kept in mind that an increase of temperature implies an increase of atmospheric pressure, with all the effects on chemical combinations and animal and vegetable development which such an increase would produce.

A Help to the Identification of Fossil Bivalve Shells. By Mr. Harry Seeley.—Students well knew that genera were practically realities, and as such the geologist and the zoologist had to do with them. Between many groups intermediate forms could not be found. The question then arose—How many genera are known? Their distinctive characters depended on the definition of a genus adopted. If it were merely a number of nearly-related species, then the descriptive characters would include those in all forms; but if it existed independently of the species being fundamental to them, then the specific characters could not enter into the description of the genus. Practically, the latter view, adopted in this paper, reduced the description to a sixth of the shortest customary lengths, whilst the distinction became clearer by pruning away much that was common to other types. But even these characters were often needlessly redundant, and several common to nearly allied groups might be cancelled. Having in this spirit examined an extensive series of lamellibranch shells, he found, in most cases, the hinge-characters among the more important residua; and shortly afterwards, whilst determining some casts of fossils in which the hinge-teeth were the only generic characters seen, it occurred to him to write the teeth down in formulæ like those used for the teeth of mammalia. Subsequent re-examination of specimens showed that in a large majority of cases these hinge-formulæ were almost the only characters with which the student need be troubled.

On the Pennine Fault. By Mr. W. Bainbridge.—The Pennine fault in the Pennine chain, the backbone of England, commenced near Tindale Fell, in Cumberland, passed near Brough and Kirby Stephen, and near Kirby Lonsdale passed under the name of the Craven fault to the vale of the Wharfe, a distance of 130 miles. Professor Phillips had minutely described the Craven fault. The researches of Professor Sedgwick did not extend further north than Brough. The Craven and the Pennine faults were on a much grander scale than the Ninety Fathom Tynedale fault, for they had rent mountains asunder, and were, in fact, immense fractures or splits along a long line of stratification. The Pennine chain was elevated on an axis which is now represented by the line of fault, but the true axis would probably reach further westward, and in time past the chain would have been higher than it is now. The slope to the western sea might have been as extensive as that now existing to the German Ocean. The author traced the igneous rock for nearly twenty miles along the base of the carboniferous chain, showing it to be of varied form and elevation, spread out into flat spaces, heaped up into lumpish hills, and rising to the skies in majestic graceful cones. The greenstone passed into slate of differing hardness, and both were found indiscriminately along the line. There were no organic remains in either. The amorphous greenstone was a dull dark substance, often liable to decomposition, but often very compact. On the western side of Dufton Pike occurred beds of granite apparently in round or oval deposits, as also in the beck to the north, like that of Shap Fell. Smooth boulders of this granite and of basalt were dispersed along the flanks of the chain northward. The granite on the Pike, and further south, contained mica. There were also veins or dykes across the line of greywacke, as at Gale, near Melmerby, containing felspar and Talc. There was no appearance of volcanic craters. Various conjectures might be hazarded as to the manner in which this mass of igneous matter was ejected. The wonderful forms of Merton and Dufton Pike seemed to prove that they began and completed their full stature after the elevation of the chain, for as fabrics like these could not at any subsequent period have been submitted to any serious aqueous disturbance, they seemed to indicate separate volcanic rests. There was no evidence in any part of the line of any extreme violence of explosion, and these pikes would probably not have survived in their present integrity any such fits of power. Their sides and summits must have been broken, and their contents reduced to the chaos apparent in other portions of the line. The growth of cones would require longer periods of time than that of pikes. It might appear to some an extravagant idea that the pikes had been burning mountains with regular volcanic rents; but, like giant cones, they might, through a central channel, age after age, pour forth their masses of liquid matter, differing in kind, but all successively hardening and consolidating the growing mountains with one fiery garment laid on another, and that, further fastened by dykes and veins of interjected substances, as they appeared to be, like the bones of a large skeleton, they might stand firm in their unsupported strength till the fires ceased to burn, and the cup was, for the last time, filled up to and beyond the brim. Some connection between the Pennine fault and the Ninety Fathom dyke had often been suggested. The dyke was first seen at Cullercoats, on the Northumberland coast, about half a mile north from the mouth of the river Tyne, where its effect was very conspicuous in throwing down the magnesian limestone, and the underlying strata, from 90 to 100 fathoms. As there was not a vestige of coal in the Pennine chain, its elevation and the crisis of the Pennine fault must have occurred either before the deposition of the coal or after the chain had been denuded of coal already deposited. But at the Tynedale fault, coal was thrown down from a considerable height. It could hardly, therefore, be doubted that coal once existed throughout the chain upon the millstone grit, and was washed off during the partial submergence of the chain. In that case it would follow that the Tynedale fault, occurring after the deposition of the magnesian limestone and before that of the New Red Sandstone, was older than the Pennine fault; and that the latter fault, with all its volcanic consequences, might have occurred within the same geological epochs, but after the effects produced by the Tynedale fault. This denudation of coal would, of course, imply an intermediate subsidence of the mountain-limestone system, during which the coal of the chain, both north and south of its depression and burial along the line of the Tynedale fault, would be washed away. It did not follow that this subsidence should be excessive. There appeared to be direct evidence in the disturbed magnesian conglomerates near Brough, that the Pennine fault, which followed the final elevation of the chain, may have occurred after the dislocation of the magnesian limestone at Cullercoats. The existence of the Ingleton coal, which may, from causes operating on a limited tract, have escaped destruction, seemed to show that the Tynedale fault must have preceded the Pennine fault; but, after all that had been said, there was abundant scope for further observations and reasoning on this difficult subject.

THE CUMBERLAND COALFIELDS AND NEW RED SANDSTONE. By Mr. M. Dunn.—In volume viii. of the Transactions of the Mining Institute of Newcastle is published a paper which the author had read on this subject. The bearing of his former paper was to show that the New Red Sandstone was traceable from St. Bees through the collieries of the whole line of coast and up to the vicinity of the village of Aspatria, where some new sinkings have recently been made by the representatives of the late Captain Harris in the New Red Sandstone, and short driftings have led directly into the main coalfield towards Bolton and the neighbouring mountain limestone. At the Ellenborough colliery the explorations have reached to the town of Maryport in the ten-quarter seam at the depth of 100 fathoms, and have there been suspended at troubled coal attended with very great thickening of the band with downcast troubles. Very much the same circumstances have attended the working of the Crosby colliery at the depth of 70 fathoms; a set of dykes and bad coal, about the same course as the margin of the Red Sandstone, terminating the profitable working of the ten-quarter seam. To the northward of the above line of explorations and down to the Solway, no operations in search of coal have been carried on, but sundry quarries have been worked, showing the Red Sandstone to be lying in regular strata, with a westerly dip similar to the coal-measures. From the above facts he had been led to form the idea that the Red Sandstone is but the superior strata of the coalfield, and that the neighbouring coal-seams will be *found underneath;* and judging from the flatness of the country around Silloth Harbour, he had assumed that the bottom of the basin will exist in that quarter, for appearances of a coal-outcrop exist in the neighbourhood of the Criffle mountains in Kircudbright. In pursuance of this theory he assumed that the coalfield of Canobie is similarly circumstanced, for the Red Sandstone there crops out contiguous to the pits, and the nature of the various seams of coal simulate closely upon those of Cumberland. Another corresponding fact attends the colliery of Kirkhouse, belonging to the Earl of Carlisle, although a portion of it also contains coals belonging to the limestone formation. He had compared the sandstone in the neighbourhood of Maryport with that upon Sir J. Graham's property at Netherby, and found that they were identical,—that is, the upper portion; the lower portion of the beds being of a much paler colour, and approximating towards the specimens of the ordinary coal sandstone. The deepest perforation which has yet been made in the New Red Sandstone was by Mr. Cockburn, papermaker, near Wetherall, who bored in search of water, but failed in obtaining a supply. In a letter in August, 1862, he said the hole is standing 600 feet from the surface, 50 feet of clay and 550 feet of red rock, which experiment shows that the rock is remarkably free from water, and that the sinkings would in all probability be free from those expensive operations incurred elsewhere. But the most convincing argument as to his theory had been furnished by the Aspatria Colliery, belonging to the representatives of the late Captain Harris, a plan of which, with its connection with the Red Sandstone, was exhibited, showing that sinking took place in the Red Sandstone with a drifting into the main coalfield; the belief of the managers was that their coal was thrown down and passed underneath the said sandstones; all around the village and down to the Solway exhibiting nothing but red rock. Since he first promulgated these opinions he had found that many persons in the district had come to the same conclusion, although certain geological objections have been started. However, he had resolved to submit the foregoing facts to be canvassed and determined by an association of gentlemen so well able to dispose of the subject, which is supposed to comprise one of the greatest fields of coal yet untouched, and which in future generations may uphold England's greatness,—one which may not have been considered in Sir W. Armstrong's able elucidation as to the duration of our northern coalfields.

On Gold in Wales. By Mr. T. A. Readwin.

Artificially-produced Quartzites.—Mr. A. Bryson exhibited specimens produced experimentally, the object of which was to prove, from the fact that cavities in quartz could not be filled up at a higher temperature than 94 degrees, that granite rock had not been formed at a high temperature.

An architect present favoured this theory. He had seen repeatedly distinct water-lines in granite, and they might be seen outside the Euston Square Station, London. There was reason to believe that certain granites were of an aqueous origin.

The Antiquity of Man. By Professor Phillips.—He said that one of the remarkable fruits of geological investigation was to invest almost every point of the earth's surface with a new interest. The small French village of St. Acheul had long been remarkable for the school of Jesuits established there; but antiquarians had discovered that it was near a burial-ground of great antiquity. In the course of excavation there were discovered the graves of people far more ancient than any known to have been buried there. Other memorials were also discovered, and on one he had obtained from the workmen he read the name of Constantius.

A stone coffin was found, and also an armlet, which had been placed on the arm of a buried person. When they looked in front of the great face of excavation and saw overhead the Jesuit College, the ancient cemetery, and the Roman and pre-Roman graves, the question arose, "What could be the antiquity of the sand and gravel deposit at the lower level?" In Sir Charles Lyell's recently-published volume the situation was fully described. Concerning the deposits there was no difference of opinion; they were to be reckoned among the later deposits of geological time, and in the lower parts of these deposits a great number of interesting implements had been obtained. He described the deposits in detail, stating that freshwater and land shells were found in gravels and sands, and an argillaceous deposit over them. For the freshwater and land shells in the gravel it was not necessary to appeal to the action of the seas, which however was seen in the lower part of the level. There were, in different levels, cases of great agitation of water, comparative agitation, and comparative tranquillity. They might imagine a lacustrine deposit, against which there would be the objection that it would not produce gravel in such a form, it being twisted about in all ways, and that there ought to have been found lying parallel to the surface of the lake a great number of lacustrine shells; such was not the case, and that explanation would not apply to the mixture of freshwater and land and amphibious shells. The more ordinary explanation was to suppose the action of a river which had changed its position, so that the flint-instruments found near the bottom might formerly have existed near the top. The arrangement of the sands was obviously of such a kind that they floated over the pebbles and covered all below. The whole question came finally to this, —Could they determine the age of the gravel beds? They could not escape the conviction that the flint-instruments were of the same age as the gravel beds. Upon the supposition of strata having been deposited by river action, the upper surface of the deposits would continually tend to become level, and would be so when the deposits were of an argillaceous nature. In this case the slope varied from 2½ to 1½ degrees. In order to account for the present condition of things, it would be necessary to suppose that the country had been disturbed, and that there had been an elevation affecting the valley of the Somme. On an examination of the locality, they would speedily arrive at the impression that it was requisite to remember that there was no period of geological history from which it was safe to exclude a movement of the earth's crust. The map of France showed the causes of the elevation. The rivers ran in parallel lines across the chalk, and it was impossible to separate the circumstance from the similar fact in this country where these phenomena had been discovered. As there was reason to think that the valley had been subject to upheaval, accepting the supposition, they would not be able to determine the question of age by the excavation of the river. If they followed the suggestion of Sir C. Lyell, and took their measure from Scandinavia, they might come to some determination as to time; but this was a case of a local disturbance of the earth's crust, affecting certain lines of country in a given direction, and apparently ceasing beyond that.

ON THE DRIFT BEDS AT MUNDESLEY, NORFOLK. By Professor Phillips.—His remarks went to confirm some views which were of the greatest importance in reasoning with regard to the antiquity of mankind, and at the same time suggesting a mode of consideration which he hoped could be followed up. The district on the coast of Norfolk, where the cliffs were formed of glacial, postglacial, and preglacial deposits, had become famous through the investigations of Mr. Taylor. Some thirty years ago in

Yorkshire, below the boulder clay, there was found a quantity of flint and chalk gravel, which contained the bones of elephants, horses, and other creatures. Soon afterwards a similar discovery was made in Norfolk. Having described these deposits, the Professor said he was inclined to think they must not venture to apply to this country any argument drawn from Scandinavia. Each country must be studied for itself, and it was better to take each class of glacial deposits separately. He thought it was possible to account for these deposits by the introduction of the tide at different levels, and that it was not at all necessary to suppose that the coast had been disturbed in order to account for the level of the marine shells. He was inclined to think that all those mammaliferous strata should be put together as the deposit of one period.

On the Alluvial Accumulations in the Valleys of the Somme and Ouse. By Mr. R. A. Godwin-Austen.

On the Discovery of Elephant and other Mammalian Remains in Oxfordshire. By Mr. G. E. Roberts.—A considerable number of elephant and other mammalian bones have recently been met with in a cutting upon a new line of railway passing through Thame, in Oxfordshire. They were taken from a coarse rubbly gravel, mixed with stiff clay, about 13 feet from the surface. The section gives a surface-clay, lightish-yellow in colour and with a sandy bottom, 11 feet in thickness, lying upon gravel, the average thickness of which is 2 feet 6 inches, and which passes downwards into a light coloured sand. About 10 feet down in the clay, a vase was found, of coarse earthenware, full of small bones, and just above the gravel another vase of coarse brown ware. The gravel extended linearly for 60 yards, and was slightly dome-shaped. Some of the bones have been submitted to Dr. Falconer, who has recognized *Elephas primigenius* of the Siberian type,—teeth and other remains rather abundant; *Elephas antiquus;* a large species of *Bos* (*primigenius?* or *priscus?*),—top of radius, tibia, and horn core; many bones and teeth of *Equus caballus fossilis*, including a finely-preserved tibia of great size and a portion of another still larger; and some good fragmentary specimens of the horns of *Cervus elaphus.*

On the Hydrography of the St. Lawrence and the Great Lakes. By Dr. Hulburt.—The effects of frosts and thaws during the Canadian winters are very remarkable on the rivers, smaller lakes, and bays of the great lakes in the valley of the St. Lawrence. One example may be given. In the winter of 1861 the writer very carefully examined those effects upon Burlington Bay, at the head of Lake Ontario. The ice at the time was about 15 inches thick. Frequent thaws occur during the winter, at all of which the ice expands with the rise of temperature. With the return of the cold the ice again contracts, but the part which has been shoved upon the shore remains stationary, and the ice opens or cracks in parts over deep water. During twenty-four hours the ice had expanded 6 feet over a distance of 2 miles, whilst it remained firm on the south side of the bay, carrying with it about 80 feet of a wharf, which broke at the centre, whilst some 80 feet nearer the shore remained firmly imbedded in the ice that had not yielded. Similar effects were produced in other places along the same shore. This expansion and contraction of the ice is sure to destroy all these bridges and wharves built upon piles and light spars in the lakes and rivers which freeze over; for the larger lakes remain open during the winter. The boulders of primitive rocks which thickly strew the valley of the St. Lawrence are found, on one shore of the smaller lakes and rivers, to have been carried by the action of the ice far away from the water; and whilst those boulders often occur so abundantly on one shore as to prevent the traveller landing, he is sure to find the other shore quite free from them.*

REPORT ON THE CHEMICAL AND MINERAL COMPOSITION OF THE GRANITES AND ASSOCIATED ROCKS OF DONEGAL. By a Committee, consisting of Mr. Scott, Sir R. Griffith, and Professor Haughton.—The first portion of the report contained a general description of the geological features of the county Donegal, with an account of the different facts observed by the members of the committee during their various tours in the county. It stated that in many particulars the non-granite rocks of the county Donegal resembled those which are described by Mr. Macfarlane as characterizing the Huronian series of Canada and its Norwegian equivalent the Tellemarken Quartz formation of Naumann, and the views put forward were supported by quotations from Mr. Macfarlane's papers in the 'Canadian Naturalist and Geologist' for 1862, from the Reports of the Geological Survey of Canada, and from Keilhau's 'Gæa Norwegica.' One of the points on which considerable stress was laid by the authors of the report was the occurrence of "a chalcedonic conglomerate, of which the cement is micaceous and the pebbles are mainly siliceous of the chalcedonic variety, but consist also of pieces of the mica-schist itself, and sometimes also of feldspar." This rock is an extremely characteristic feature of the north-east of the county Donegal, and may perhaps be found to be present in a corresponding position in Scotland, as it would appear that conglomerates of a similar nature have been observed by Sir H. Griffith at Anie, in the neighbourhood of Callander, and by Professor Haughton at the summit level of the Crinan canal. The igneous rocks, which are very abundant in the county, were found to be regularly interstratified with the grits seen in Limshowan, while in the south of the county rocks of a similar constitution were found to be intrusive. Analyses of both varieties were given in the Report. The coarse-grained varieties of these rocks were all termed by the authors syenites, as they class under the generic term syenites all rocks which consist mainly of a hornblendic mineral associated with a feldspar, and with a quartz or mica, or both. This term includes diorite and other rocks whose nomenclature seems at present to be not quite fixed, as the names are used in different senses by different authors. Limestone was found in considerable abundance; no fossils have been discovered in it, and it passes into crystalline marble in the neighbourhood of the granite. As to the granite itself, it contains the two feldspars orthoclase and oligoclase, with black mica, quartz, and almost universally small crystals of sphene. In some varieties of the rock it is so abundant as to induce the authors of the report to term it sphenic granite. This mineral has been long known to exist in the granite of parts of Scotland, and it is also found in that of Galway. Evidence was adduced to show the gneissose character of the granite when seen in the field, and its passage by insensible gradation into gneiss and mica-schist in a manner precisely similar to that described by Keilhau as having been observed by him in Norway. In addition to this fact, attention has been drawn to the stratified nature of the granite, and to the occurrence of gneiss and of limestone in several localities within its area. In such cases the limestone is extremely rich in minerals, and is generally accompanied by a peculiar rock, called by the authors "sphene rock," which consists of orthoclase, quartz, and pyroxene, with sphene in extreme abundance; and a quotation was made from the Canadian reports before referred to, to show that a similar connection of these rocks had been observed in Canada. The report did not contain any statements relative to the age of the rocks of Donegal, but it expressed a hope that the labours of the Geological Survey of Ireland in Connaught and of the Survey of Scotland would shortly afford data on which sound reasoning as to the age of the Donegal rocks might be based. The chemical constitution of the granites, syenites, and the included minerals, was then discussed. Most of the analyses have already been brought before the Geological Society of London, and published in volume xviii. of the Quarterly Journal. In addition to these, two analyses of Scotch granites were given, one from Strontian and the other from Tobermory, which had been selected owing to their similarity to some of the Donegal granites. The report concluded with an important investigation into the mineralogical constitution of the granites, which was furnished by Professor Haughton. Only the results of the calculation were laid before the Association.

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* See also for the subject, 'Geologist,' vol. i. p. 539 (1858).

It will be seen from the paper which has been already printed (Quart. Journ. vol. xviii. p. 403), that there are four equations to determine four unknown quantities, namely, the quartz, orthoclase, oligoclase, and black mica, which are assumed to compose the granites in which they are actually present, and whose composition is taken exclusively from the analyses of specimens obtained in the district under examination. From the coefficients of the four equations, which may be at once reduced to three by elimination of the quartz, ten constants are obtained, by the use of which the percentages are at once found. The application of this method of calculation to the seventeen analyses of granite and granite rocks, which are given in the report, leads to results which are unexpected. Nine of the granites give negative values to some one or more of the unknown quantities, and therefore cannot consist of the four minerals above mentioned. The remaining eight give positive values, and therefore may consist of these minerals. On applying to these eight granites further tests furnished by equations relating to the different protoxide bases, it is found that not a single one satisfies all the conditions exactly; however, the degree of approximation between the calculated and observed percentages of the constituents is very close, as was shown by an example. From this result it follows that not a single granite of those which were examined can be represented by four minerals having the precise composition given in the report, although nearly one-half of them might be represented by minerals having the same oxygen ratios as those assumed. Hence the authors would conclude that, as has been suggested by many petrologists, it is unsafe to draw conclusions as to the mineralogical composition of a rock like granite from the analysis of minerals picked out of veins and other coarse-grained portions of the rock, and that it is *à fortiori* more unsafe to apply to the case of any granite analysis of foreign specimens of minerals, which have never been proved to exist in the district in which the granite occurs. The actual specimens which have been analysed are deposited in the museum of Trinity College, Dublin, and a duplicate series in that of the Royal Dublin Society. A catalogue of the mineral localities of Donegal was appended to the report. Upwards of sixty species have been observed.

REPORT OF THE SHETLAND DREDGING COMMITTEE IN ITS GEOLOGICAL BEARINGS. By Mr. J. Gwyn Jeffreys.—The paper had been previously read in the Zoological Section.

ON THE ORIGIN OF THE JOINTED PRISMATIC STRUCTURE IN BASALTS AND OTHER IGNEOUS ROCKS. By Professor James Thompson.—The Professor's belief was that shrinkage was the cause of fracture and columnar structure, and that a peculiar tension starting from a central line was the cause of the very curious joint-structure, which was nowhere better exhibited than at the Giant's Causeway.

ON THE BIVALVED ENTOMOSTRACA OF THE CARBONIFEROUS STRATA OF GREAT BRITAIN AND IRELAND. By Professor Rupert Jones.

FOSSIL FISHES FROM THE PERMIAN LIMESTONE. By Mr. J. W. Kirkby.—The object of the paper was to record the discovery of fish-remains in the Upper Magnesian limestone of the Permian formation, the discovery being of interest, especially on account of the remains having been found at a horizon considerably higher in the Permian series than any vertebrate remains had been previously known to occur. The fossils were first noticed in August, 1861, in a newly-opened quarry belonging to Sir Hedworth Williamson, at Fulwell, a mile and a half to the north of Sunderland. Most of them are found in one bed or zone of beds of limestone, there nevertheless being several instances of their occurrence both above and below. The same fish-bed appeared to extend considerably to the north-east, a portion of a small fish having been obtained from Marsden Bay. The fossils were almost invariably perfect individuals. Fully nine-tenths of the specimens found belonged to a single species of Palæoniscus. The remainder belonged probably to two, or probably to three, species of the same genus and to a species of Acrolepis. The Palæonisci were small, the largest being but little over 4 inches in length. The Acrolepis seemed to have attained a length of 12 inches. Associated with the fish-remains there occurred rarely fragments of plants. These, though imperfect, appeared to be referable to three species; one a Calamite, another a Caulerpa, and the third was a large reed-like form, whose generic relations were at present difficult to determine. These were the only fossils that had been met with along with the fish. These fish-bearing strata were 150 feet from the top of the upper limestone. The discovery carried the Permian vertebrate from the lower beds of the Durham series high into the upper, and near enough to the Trias to give to their occurrence perhaps more than usual interest.

Mr. Howse suggested that as the Palæoniscus was a freshwater fish, and the magnesian limestone not a freshwater formation, the plants had been drifted with the fish into the sea, and both deposited together in the limestone.

SWEDISH FOSSILS.—Mr. J. G. Jeffreys gave a list of the Upper Tertiary fossils of Uddewalla, in Sweden.

ON THE UPPER TERTIARY STRATA OF THE BOHUSLAN DISTRICT. By Dr. A. W. Malm.—This was another contribution from Sweden. It had been accompanied by a slab, which, unfortunately, excited the suspicions of the Customs' officers, who, suspecting perhaps the concealment of brandy or cigars, or concluding that the slab was rubbish, had broken it up and destroyed it.

The President, Mr. Warington Smyth, remarked that observation was now establishing, beyond the possibility of a doubt, that certain portions of the north of Europe were now being elevated at a slow, still, comparatively speaking, rapid rate above the level of the sea, and also that we had in our country, especially in Wales, most conclusive evidence that the land had been elevated to an enormous height within a comparatively recent period. Dr. Malm had shown that there had been almost magical transformation in Sweden; but nearer home we might find the same class of phenomena. He had now to call attention to a most extraordinary depression between Durham and the south of the Tyne. A paper to be read showed that at a recent period, comparatively speaking, there had been a channel of considerable depth between Durham and a point above the High Level Bridge. The subject was of much importance to the coal trade, and it had excited great interest among viewers and miners generally.

A WASH OR DRIFT THROUGH THE COALFIELDS OF DURHAM. By Messrs. N. Wood and E. F. Boyd.—The course of an ancient river, to which the paper related, differed from the courses of the Tyne and of the Wear. It passed almost in a direct line from Durham to the river Tyne at Newcastle. It was 93 feet below the present level of the Wear, and 140 feet below the level of the foundations of the High Level Bridge, which were 30 feet below the bottom of the river. Having, in the prosecution of their professional duties, had many opportunities of collecting information of the particulars of the thicknesses of the covering of gravel, sand, and clay spread over the surface of the coalfield of Durham more particularly, in various situations and under different circumstances, and having had frequent opportunities of observing the effect of the abrasion of the mineral strata of the districts, and especially of a particular wash or drift in the coalfield of Durham which has denuded a considerable portion of the coal-measures, the authors laid before the Association the results of their experience. Premising that such a wash or drift can be traced through the coalfield from the vicinity of the city of Durham to the river Tyne at Newcastle, traversing a portion of the valley of the Wear, passing Chester-le-Street, and following the valley of the river Team, and terminating at the river Tyne, their communication consisted of a plan of the district in question, and a series of sections showing the line of the wash and the depth to which it extends, with various other particulars. An examination of the different cross sections, particularly those nearest to the river Tyne, will encourage the idea that the deepest portion of the denudation was by the eastern side, and that the edges of the strata nearest to that side are more upright and abrupt. No trace of shells whatever has been found in any part of its course, nor of bones or animal remains. The pieces of shale which were observed entire and resting on edge against the eastern side, as if recently broken from their stratified bed, contained on examination the usual ferns and plants of the Carboniferous series; all the stones and pebbles in having their edges entirely removed and rendered smooth, particularly those of harder character, bore evidence of long exposure to the abrading influence of water in motion, and whenever the bottom on which the diluvium rests was exposed, there are unmistakable evidences that the water which carried the débris was in motion and of great power. At the sinking of the Ouston pit, the first solid strata met with after sinking through the 23½ fathoms of clay and sand was a strong freestone, the upper surface of which was furrowed with rough and scored outlines and polished, as may be noticed in the exposed bed of a mountain-torrent passing over a strong rock. The edges of the coal-seams adjoining the denudation, as the Hutton seam by Harbour House and Frankland, and the main coal-seam at Urpeth, were worn and rounded off in some instances where the upper portion of the seam having been tender had given way to the abrading action, whilst portions of that nearer the floor remained, the intervening parts being filled up with clay and boulders and broken pieces of coal. The contemplation of this remarkable deposit suggests to the authors considerations of the following character:—1. The extent and cause of opposition which the dislodged waters of the ocean met with in their progress to their ultimate sea-level. If the magnesian limestone hills of Boldon, Pensher, Houghton, Pittington, and Quarrington (superimposed over the coal-measures), formed as decided a barrier as they now present. 2. The quantity of débris with which they were charged, and the opportunity thus afforded them of depositing these by the action of gravitation, exercised during the above opposition met with, until the silting process was completed up to the level at which the waters of Tyne and Wear now run over its surface. 3. As prior to this silting process the waters which caused the denudation must have been in motion at a point at a depth of 140 feet below the present level of the ocean, is it unreasonable to suppose that the whole length of the valley in which it occurs was once at a higher level than that at which it now exists? 4. When the deep areas thus depressed and excavated were sufficiently silted up, the flow of waters, the produce of drainage and springs in higher grounds, would flow off at the easiest level to the sea by the present course of the rivers Tyne and Wear, the diversion in favour of the latter being possibly induced by the subsidence of so large a thickness of coal strata as occurs at Monkwearmouth, being here not less than 2500 feet in depth, and composed extensively of argillaceous shales, which are known to contract considerably in drying after being in a moist condition.

PERMIAN ROCKS OF THE NORTH-WEST OF ENGLAND. By Sir Roderick Murchison.—The author described the Permian rocks as the newest palæozoic deposits forming a natural group, characterized by community of animal and vegetable forms in various parts of Europe; and until he proposed the term Permian, this group had no collective name. In the east of England there was no perceptible deposit that could be classed with the Permian. In the north-west, particularly at St. Bees' Head and in the valleys leading from the river Eden to the Pennine range, there was a remarkable display of rocks, sandstones, and conglomerates, which were linked indissolubly and conformably with the magnesian limestones. The lower portion of the deposit, over a very large portion of England, was formerly called the Lower Red Sandstone. All these deposits had been, in the first instance, admirably described by Professor Sedgwick, whose description had been the foundation of all our knowledge on this subject. His reason for proposing this simple name was that he found on the Continent the representatives of the formation spread over a country twice as large as France; and when the same community of character was found in this country, our geologists adopted the name. He had asserted that in Germany there was a great overlying sandstone superposed on the magnesian limestone which formed the upper part of the group, and he showed, in all sections that were typical, that this mass of sandstone went with the magnesian limestone, and was completely separated from the Triassic deposits which were named the New Red Sandstones. This conclusion was steadily contested by many German authorities, who did not like to part with any portion of their Bunter Sandstein or to accord any part of it to his Permian group. Amongst those who opposed this view was Dr. Geinitz, who had endeavoured to show that it was a dual deposit and not a triad deposit, and he now called it Dias. Against that he (Sir Roderick) had entered his protest. The labours of Mr. Binney, followed by those of Professor Harkness, had, confirmed by his own survey of the rocks, proved that in reality the west side of England offered the most complete confirmation that could be given of the *tripartite* arrangement of the Permian group, and completely fortified him in the opinion that the Germans were wrong and that he was right. A detailed examination of the rocks, which he had been looking at with Professor Harkness, had led him to the conviction that if you ascend any one of the little groups, particularly the Hilton group, from the vale of Eden, up to the great Pennine fault, you will find a succession of conglomerate beds overlying the enormous mass of the lower portion of this great group. The details had been explained by Professor Harkness, whose observations he confirmed. He called attention to the value of them in reference to certain beds of plants which were absolutely Permian plants. Above the limestone and conglomerate came a series of clays or shales associated with the sandstone. They passed conformably, without any break whatever, into the Upper Sandstone. He was sure Mr. Binney would sustain all he had said in reference to this group being a great palæozoic Trias. He did not like the words Dias and Trias, because in England we had no Trias; there was no central member of the system; the name was given to that superior formation by a German geologist because the division was clear in his part of his country. It was not so, however, in other parts; and no general name ought to be given from the divisions of rocks happening in any one country. St. Bees' Head exhibited a small and most instructive portion of the roth-todte-liegende of the Germans, or the Lower Red Sandstone of English geologists. The conglomerates which were deposited unconformably on the summit, called sandstones in that country, were eroded in a most irregular manner, and the breccia entered into all the sinuosities, showing in that part a complete physical break between the coal, the sandstones, and the superjacent Permian rocks. This was an important point, because an eminent German geologist had endeavoured to class this roth-todte-liegende with the coal-deposit. St. Bees' Head was an instance of the total separation of the carboniferous formation and the beginning of a new series of things in these breccia, gravel and sand. Immediately upon this breccia, the representative of the yellow sandstones, which underlie the magnesian limestone to the west, comes clearly and unequivocally the magnesian limestone, filled with such fossils as would be found at Sunderland and along the Hartlepool coast. There they had, then, magnesian limestone distinctly resting on this lower breccia, and superposed and passing upwards, without the slightest break in the argillaceous beds, into the sandstones. He would say a word on a point of importance to gentlemen living in mining districts. In Germany this deposit would not have been known so well had there not existed under it a certain thin band called kupfer-schiefer, which, though thin, was in that part of Germany explored most pertinaciously. In this country the roth-todte-liegende afforded no mineral substance, and we had been hitherto unacquainted with the value of a deposit to which he would now call attention. It was the most important mineral deposit that had ever been discovered in the north-west of England, and it was enriching the people to an incredible extent. He referred to the hæmatite deposits in the cavities of the mountain-limestone. It had often been asked,—To what age are we to attribute this enormous infilling with this hæmatite ironstone? There were some who had attributed it to Tertiary periods. Professor Phillips was the first who made the suggestion that it was probably connected with the very series of deposits to which he now called attention. He had said that at the bottom of this series was this great accumulation of breccia. It was distinctly seen as forming the bottom parts of it in many parts of Furness. The hæmatite had been frequently worked out by old workmen from the cavities under the breccia. This discovery enriched his Permian group, and it showed that that period of the earth, so remarkable in Germany for the up-pouring of porphyry, and the great change which took place in the earth's condition after the formation of coal, enriched the Permian system by the formation of a deposit of the richest and most valuable mineral in the British Isles.

Mr. Kirkby said the Permian system was as entirely connected with the mountain-limestone and with the carboniferous system, as the Cambrian was with the Silurian.

ON A FOSSIL SALAMANDER. By Dr. Geinitz, of Dresden.—An interesting fossil had been found in the Lower Permian or Dyas of Dr. Geinitz, in the neighbourhood of Braunan, north-east of Bohemia, by Dr. Bernent. It was found some years ago in a slab of grey marl slate, belonging to the Lower Roth-liegende, not to the Kupfer-schiefer. Captain Ibbetson had proved the relation of this class of fossils with the living siren (*Lacertina*) of North Carolina, so that he was persuaded he had in the fossil an old and gigantic siren or salamander, whose dimensions exceeded those of the living species about ten times. There were preserved three and a half vertebræ, with a part of the skin, and the name proposed was *Palæosiren Bernenti.*

THE SANDSTONE OF THE NORTH-EAST OF SCOTLAND. By Professor Harkness.

ON ROCK-SALT AT MIDDLESBROUGH. By Mr. John Marley.—The paper was a sketch of the discovery of rock-salt at Middlesbro'. Messrs. Bolckow and Vaughan, who have proved this salt, were the first to commence ironworks at Middlesbro' some twenty-three years ago; also, were the first to make the practical application of the discovery of the Cleveland ironstone fifteen years ago, and opened their Eston ironstone mines, near Middlesbro', thirteen years ago, having since then vended about six million tons of ironstone therefrom. In 1863 they have the honour of the discovery of salt in that district. The requirement of fresh water by Messrs. Bolckow and Vaughan, in connection with their ironworks at Middlesbro', being large, they commenced, about four years ago, to sink a well. The shaft was carried to a depth of 180 feet; and owing to the top feeders being in connection with the flow of the tide in the river Tees, and consequently brackish, they were tubbed back with metal tubbing, and others being freshwater feeders were also tubbed back, but arranged with sluices so as to be available when required. The supply of fresh water not being considered sufficient, a very large bore-hole was commenced, about a year ago, from the bottom of the shaft, at the depth stated, under the direction of Mr. Homersham, C.E., of London, and, with the boring machinery of Messrs. Mather and Platt, of the Salford Ironworks, Manchester, worked by steam and flat wire-rope, a bore of 18 inches diameter has been put down to the present extreme depth of 1306 feet. In going through the Red Sandstone, the maximum rate attained was 13 feet in thirteen hours' shift, *i.e.* 1 foot per hour; and even when upwards of 1100 feet deep, a rate of 3¼ feet per thirteen hours, or 3 inches per hour, has been attained. The details of the nature of the strata bored through is given in the sections, and belong to the Upper New Red Sandstone or Trias formation, the same as the rock-salt deposits of Cheshire. The rock-salt was first pierced at a depth of 1206 feet, and the bottom is not yet proved, but is already 100 feet into it. The quantity and quality of the brine has not yet been fully tested, but the author had received the following analysis:—

Chloride of Sodium	96·63	per cent.
Sulphate of Lime	3·09	,,
Sulphate of Magnesia	0·08	,,
Sulphate of Soda	0·10	,,
Silica	0·06	,,
Oxide of Iron	trace	,,
Moisture	0·04	,,
	100·00	

The extent or area of this deposit it is not yet possible to estimate. On the north we have, at Castle Eden Colliery, the coal-measures overlaid by the Permian; and at Oughton Colliery, nearer to the Tees, the Trias has been bored into some 500 feet; the Hutton coal-seam, at Castle Eden Colliery, being some 750 feet below the sea-level, and the salt at Middlesbro' about 1250 feet; on the south side of the Tees the Lower Lias puts on and is capped by the Upper Lias and Oolitic strata—these strata dipping both to the south and north from the Tees. The following is an account of the strata sunk and bored through:—

No.		Fm.	ft.	in.
1.	Made ground (slag, chalk, etc.)	1	5	0
2.	Dry slime or river mud	1	2	0
3.	Sand with water	1	4	0
4.	Hard clay (dry)	1	4	0
5.	Red sand with a little water	0	1	0
6.	Loomy sand with a little water	0	3	0
7.	Hard clay (dry)	2	3	0
8.	Rock, mixed with clay and water	1	5	0
9.	Rock, mixed with clay (dry)	0	1	0
10.	Rock, mixed with gypsum (dry)	1	0	0
11.	Gypsum with water	0	2	0
12.	Red sandstone with small veins of gypsum and water	9	1	0
13.	Gypsum rock (dry)	1	0	0
14.	Brown shale with water	0	1	0
15.	Red sandstone	0	4	0
16.	Do. with small veins of gypsum and water	2	0	0
17.	Blue poststone with water at bottom	0	3	0
18.	Red sandstone with water	3	1	0
	Bottom of sinking	29	4	0
19.	Redstone	72	5	4
20.	Red and white sandstone	0	1	6
21.	Red sandstone	35	5	7
22.	Do. and clay	0	1	0
23.	Red sandstone	8	4	3
24.	Do. and clay	1	3	0
25.	Do.	11	0	5
26.	Strong clay	0	2	9
27.	Red sandstone and clay	0	1	6
28.	Do.	4	3	5
29.	Do. and clay	1	3	0
30.	Do. with a vein of blue rock 1¼ thick at 1005 feet	8	1	4
31.	Red and blue sandstone	0	1	5
32.	Red sandstone	1	0	0
33.	Do. and thin veins of gypsum	0	1	5
34.	Do. do.	6	3	8
35.	Red sandstone, blue clay, and gypsum	0	1	2
36.	Do. with veins of gypsum	14	3	3
37.	Gypsum	0	3	2
38.	White stone	0	0	8
39.	Limestone	0	2	8
40.	Blue rock	0	0	2
41.	Blue clay	0	0	2
42.	Hard blue and red rock	0	0	10
43.	White stone	0	2	7
44.	Dark red rock	0	1	2
45.	Dark red rock, rather salt	0	6	7
46.	Salt rock, rather dark (1)	2	0	7
47.	Do. very dark (2)	0	4	1

48. Salt rock, very light (3)		0	3	6
49. Do. rather dark (4)		4	3	4
50. Do. very light (5)		7	1	6
51. Do. rather light (6)		1	3	0
Total depth up to and with Saturday, 29th of August, 1863		217	4	0

The six items = 100 feet of salt (but not yet through) equal to 1306 feet.

Mr. Marley thought it premature to speculate upon the beneficial effects of the discovery, or as to its bearing upon the possibility of there being coal under the Lias in Cleveland.

Mr. Pattinson, analytical chemist, said that the importance of the discovery of this rock-salt at Middlesbro' would be appreciated when it was stated that the Newcastle district consumed annually 100,000 tons of salt, which was chiefly obtained from the Cheshire district. The alkali manufactures of this country existed in two districts—those of Lancashire and the Tyne. The manufacturers of Lancashire had a great advantage in the Cheshire salt being so near at hand; but this discovery at Middlesbro' would give the Tyne manufacturers a decided advantage. Another advantage would also be gained. There was a large quantity of heat wasted at present: one-third of the coal was wasted in producing coke, and in the iron manufacture a large quantity of heat was wasted in the blast, puddling, and other furnaces; and great economy might be effected by evaporating the brine, which he hoped would be pumped from this bed of rock-salt. It would be an excellent method of economizing the waste heat from coke-ovens, the loss of which had been so long lamented by every one anxious about the coal of the district.

ON SOME REMAINS OF BOTHRIOLEPIS FROM THE UPPER DEVONIAN SANDSTONES OF ELGIN. By Mr. G. E. Roberts.—The genus was instituted in 1840 for the reception of fossil remains evidently belonging to a large Dendrodic Celocanth allied to the Asterolepis. Although the shape and arrangement of the dorsal scutes of this great fish were tolerably well known from the abundance of specimens collected in Russia and Scotland, the plates covering the head have not hitherto been found, save in fragments too insignificant for determination. The author had obtained, during a recent visit to Scotland, some of the missing data. They consisted of two large and nearly perfect casts of the cranial buckler from the Upper Devonian Sandstones of Newton, by Elgin, for the loan of which he was indebted to Dr. Taylor, of that town; three considerable portions of the thick enamelled head-plates from the same locality, belonging to the Elgin Museum; a cast of a portion of a hyoid bone from the collection of the Rev. Dr. Gordon; three casts of opercular and mastoid bones from the yellow grits of Alves, and three portions of head-plates from the same locality, preserved under slightly different conditions to the specimens from the Newton zone, both lent by Mr. Smith, of Inverness. In 1836, Dr. Malcomson, of Elgin, called attention to fish-remains in a calciferous conglomerate discovered by the Rev. Dr. Gordon, of Binnie, and assigned a stratigraphical position to them, which the recent labours of Professor Harkness have verified. The author accompanied that gentleman to the quarries which gave the deciding data, and he placed the grey and yellow sandstone grit of Newton and Alves immediately beneath the fossiliferous sandstones of Scat crag. Upon these latter beds lie the Holoptychius yielding sandstones of Bishop's Mill, covered in turn by pebbly beds and the famous sandstone of Lossiemouth, which contains the Stagonolepis. The whole series he regarded as true Upper Devonian. After detailed description of the head, the author remarked that Bothriolepis had been presumed to be a congener of Asterolepis, and perhaps rightly so; but we knew too little of the family of Dendrodic Celocanths to justify us in regarding any one as a central type. From the investigation he had lately made into the fish-bearing sandstone of Elgin, he was convinced that enough material might be got together, with a moderate expenditure of time and trouble, to elucidate the true character, form, and proportions of Bothriolepis, so long an enigma in fossil ichnology. The studies of Professor Harkness in the physical history and relative position of this most interesting series of sedimentary deposits ought, and probably would, draw the attention of geologists in general to deposits which, though possessing local characters, were yet of world-wide value, as giving solutions to questions which rocks far distant had given rise to, and for which Continental geologists had long asked in vain.

ON A NEW STARFISH (CRIBELLITES CARBONARIUS) FROM THE MOUNTAIN LIMESTONE OF NORTHUMBERLAND. By Mr. George Tate.—The paper commenced by noticing its association with carboniferous plants. Previously no species of Asteroidea had been recorded from this formation. The specimen exhibited, found by Mr. W. Wilson, of Shilbottle, was an impression of the upper surface only of the organism, in a yellow, fine-grained, micaceous sandstone, and, although imperfect, was doubtless a sea-star, and, as the first discovered in the formation, it deserved the attention of palæontologists. The following characters could be observed:—Rays five, rounded, lanceolate, five times as long as the disk, ridged in the centre, covered with longitudinal rows of reticulating tubercles; disk small and tuberculated. The disk was only ·3 of an inch in diameter, whilst the rays were 1·5 inch in length. The sandstone from which this sea-star was obtained was about 20 feet above the Shilbottle coal, and about 10 feet below the "18-foot limestone," which was the fifth limestone sill in the mountain limestone of Northumberland; it was, he estimated, about 600 feet below the base of the millstone grit, and, as the formation was about 3000 feet in thickness, it was in the upper part of this series of beds. The paper proceeded:—"Besides the sand-star, there occur in this sandstone *Strophomena crenistria* and the remains of plants. This association is of some interest. Numerous marine organisms in the limestones and in shales connected with them, belonging to the mountain limestone of Northumberland, abundantly evidence the deposition of such beds under marine conditions; but rarely are marine organisms seen in the sandstones which form a large proportion of this formation in Northumberland. Another sandstone higher up in the series, appearing in a quarry, exhibits, however, a similar association. This sandstone, which is 23 feet in thickness, has a thin layer, one foot thick, which is crowded with *Strophomena crenistria;* but, both in the beds above and those below it, there are many fragments of carboniferous plants of the genera Sigillaria, Lepidodendron, Calamites, Knorria, and the *Stigmaria ficoides.* These cases prove, the author thinks, that some of the sandstones of the mountain-limestone of Northumberland were deposited in shallow bays of the sea, in which marine organisms lived, and into which were drifted plants which grew during the carboniferous era. These facts, however, do not invalidate the conclusion that coal was formed of plants which grew on the places where coal-beds are now found, for even in the Northumberland mountain-limestone formation each coal-seam rests on an under clay, which was the muddy and probably swampy soil in which the carboniferous flora grew. Sometimes a limestone, with marine fossils, overlies a coal-seam; but we never find a limestone or calcareous bed with marine fossils lying below it." The paper then noticed other beds that showed changing conditions during the period of their deposition, and concluded with the remark that the facts appeared to show a change of conditions while the beds were in course of formation. At first the conditions were unquestionably marine, but, from some unknown cause, probably from a gradual alteration of level and an influx of freshwater, these conditions became estuarine, and probably even entirely freshwater.

THE WEARDALE IRON ORES. By Mr. Charles Attwood.—In Weardale, iron ores, occurring as they do under the two different forms of spathose or sparry carbonate and of hydrated peroxides, have certainly been all at first deposited as carbonates, and have passed into the state of oxides and of hydrates by the joint effects of atmospheric and of aqueous action. Examples of every stage of the transition present themselves in all directions, and there are also met with, from time to time, abundant proofs that, whilst the carbonates deposited are more or less rapidly passing into the hydrated condition, a fresh deposit of carbonates is continually going on in the mines in cavernous interstices, and on the roofs and sides of ancient workings, very much in the same way as stalactites and stalagmites are deposited. Upon one occasion he found protruding, for 5 or 6 inches, from a block of pure and large-grained sparry carbonate of iron, a rod of malleable iron, of about a quarter of an inch in diameter, of which the other end was firmly embedded to about the same depth in the block, which had just before been broken from a mass of it, which was incrusting the walls and roof of an ancient drift, but which block must have been formed within one or two centuries. The author then suggests the importance, in geological considerations, of the solvent power of water containing alkalis, and the resulting deposition of silica and siliceous minerals.

SECTION OF THE STRATA FROM HOWNES GILL TO CROSS FELL. By Mr. Sopwith.—At the last meeting of the British Association in this town it was proposed that a section should be made from sea to sea, crossing the coal- and lead-measures of Northumberland and Durham, the great Pennine fault, the Red Sandstones of Cumberland, the Skiddaw group of mountains, and the coalfields at Whitehaven. The late Mr. Buddle undertook the portion from the German Ocean to Hownes Gill, including the entire strata of the Durham coal-field; but it was uncompleted at the time of his death, and the section now exhibited was the only part which was executed. It is upwards of 30 feet in length, and represents in great detail the strata of more than twenty-eight miles of the lead-mining districts. Mr. Sopwith especially mentioned his obligations to Mr. Joseph Dickinson for the care and accuracy with which he made the several measurements on which this section is based.

ON THE NEANDERTHAL SKULL. By Professor W. King.—The author gave his reasons for believing it to belong to the Clydian period and to be specifically distinct from man. He contended that the Neanderthal man was living in the terminal division of the glacial or Clydian period. In concluding, he adverted to a question involved in the present subject, and on which a preconceived prejudice is generally entertained. Agassiz, Latham, and a few others, including Huxley, would have no hesitation in admitting that the genus *Homo* has been represented by more than the one species now living; but there is unquestionably prevailing a deep-rooted conviction that the psychical and speech endowments of *Homo sapiens* are generic, although there is nothing to warrant such a belief, and much to oppose it. For his part, he saw no reason to doubt that there have been species of the human genus in existence unpossessed of those gifts which so eminently place the existing races, but in different degrees, above the highest anthropoid apes. Why may there not have been a Pliocene or a Clydian species, possessed of no higher faculties than such as would enable it to erect a protecting shed, fashion a stone for special purposes, or store up food for winter; but, like the gorilla or chimpanzee, be devoid of speech, and equally as unconscious of the existence of a Godhead? Man's psychical endowments are visibly expressed in the prominent frontal and the elevated vertex of his cranium. But, considering that the Neanderthal skull is eminently simian in its great characters, he felt constrained to believe that the thoughts and desires which once dwelt within it had never soared beyond that of the brute. The Andamaner indisputably possesses the dimmest conceptions as to the existence of the Creator: his ideas on this subject, and of his own moral obligations, place him very little above animals of marked sagacity; nevertheless they are such as to specifically identify him with *Homo sapiens*. Furthermore, the strictly human conformation of his brain-case bears out the collocation. Psychical gifts of a lower grade than those characterizing the Andamaners cannot be conceived to exist; they stand next to brute benightedness. Applying the above argument to the Neanderthal skull, and considering its close resemblance to that of the chimpanzee, and, moreover, knowing that the simian peculiarities are unimprovable — incapable of moral and theositic conceptions—the author saw no reason to believe otherwise than that similar darkness characterized the beings whom he did not hesitate to call *Homo Neanderthalensis.*

Fish-Remains in the Coal-Measures of Northumberland and Durham. By Messrs. T. Atthey and W. J. Kirkby.—Notwithstanding the great attention that has been paid to the vegetable fossils of this coal-field, very little is known of the fossil animals associated with them. In this respect the palæontology of the Durham and Northumberland coal-measures has been neglected, compared with what has has been done in several other coal-fields; for in the coal-measures of Yorkshire, Lancashire, Staffordshire, etc., these fossils have not only been carefully collected, but to some extent described, in the memoirs of Messrs. Hibbert, Binney, and Denny. The highest horizon at which the authors have observed fish-remains in the coal-measures of this district is apparently situate not many fathoms from their summit, or, to speak more precisely, from the base of the Lower Red Sandstone. The fossils referred to are found in some dark grey shales with nodular bands of ironstone, and in overlying beds of black and highly-carbonaceous shale or "blackstone." These beds are exposed on the north bank of the Wear opposite to Claxheugh, where they are brought up by an upcast fault to the east that crosses the river a little to the west of their outcrop. From the "blackstone," which apparently forms a very thin bed, there have been obtained scattered ganoid scales of small size, which evidently belong to species of Palæoniscus or Amblypterus. With them have also occurred a small maxillary and some other detached bones, which, so far as size is concerned, may belong to the same fish or fishes as the scales. These remains do not pass down into the underlying shale, but in place of them we there find large quantities of a small suboval or orbicular shell, which in the shale itself is pressed flat, but in the ironstone is flatly conical or patelliform. This fossil does not attain more than one-eighth of an inch in length, being generally less, is extremely thin, shows several coarse concentric wrinkles or plaits, and has an apex or umbo placed away from the centre. In specimens from the shale the umbo is not symmetrically placed. Specimens of this shell in the possession of Mr. Vint, from a lost locality, were shown to Professor Phillips more than twenty years ago, and referred by him to Ancylus. On rediscovering the fossil this year, the authors thought it an Estheria, but it is not considered by Professor Rupert Jones and Mr. T. Davidson to be a Discina. In the shale it is always more or less scattered, but in the ironstone it is so abundant in certain zones as to cover the whole of the surface. Associated with this fossil, both in the shale and the ironstone, are specimens of *Beyrichia arcuata,* and in the ironstone alone a few obscure vegetable remains.

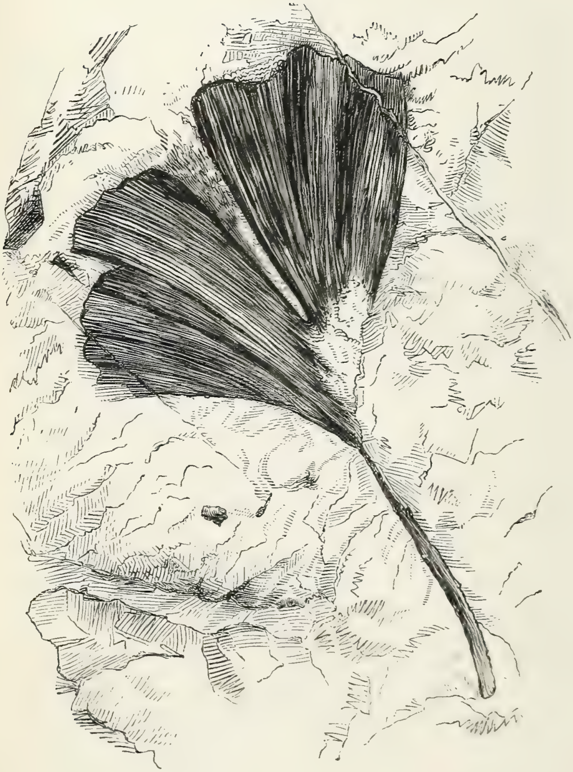
About 100 fathoms below the horizon of the preceding fossils another zone of fish-remains occurs, and in the intermediate space more than one band of Anthracosia and Anthracomya. The stratum that chiefly yielded the fish-remains was passed through in sinking the Ryhope Colliery, near Sunderland, and it consists of highly-carbonaceous black shale with intercalations of coal, or, as the miners term it, "blackstone and coal-pipes mixed." Immediately over it is a 3-inch seam of splint-coal. From this bed the authors have taken the finely-enamelled scales of *Megalichthys Hibberti,* and others usually referred to Holoptychius, as well as such as evidently belong to species of Palæoniscus or Amblypterus; also sauroid teeth of various sizes, the larger of which appear to belong to Megalichthys or Rhizodus, and the teeth of *Diplodus gibbosus.* Along with these occurred various detached bones and coprolites; and on one horizon great numbers of Anthracomya were associated, and with them two species of Entomostraca,—*Cytheropsis Scotoburdigalensis* and a form yet undescribed. Remains of plants, too, were not uncommon in this bed. Immediately overlying the splint-coal is another stratum of black shale, 4 feet 2 inches thick, and this is overlaid by grey shale to the thickness of 36 feet. In these beds the remains of fish were also found rarely, and with them, towards their base, were also met with specimens of *Lingula mytiloides* (Syn. *Credneri*), examples of which we believe we also got from the blackstone underlying the splint-coal.

The next horizon at which the remains of fish have been noticed is about 120 fathoms below the one just mentioned, in a thin bed of black shale or "stone" that rests on the top of the Low Main Coal, at Newsham, about 10 miles north-east of Newcastle. The remains would appear to be far more abundant on this horizon than on any hitherto discovered; and there has been obtained from the black shale that marks it, one of the finest series of carboniferous fish-remains that perhaps exist in the north of England. These fossils consist of scales, spines, jaws, teeth, and bones, the most important of which we notice below. Amongst the most interesting are some large spines of Placoideans. The most common of these is the *Gyracanthus tuberculatus,* of Agassiz. Perfect examples of this spine measure 15½ inches in length and 6½ inches in circumference. It is a notable feature in them that they are nearly always much worn at the point, as though they had been subjected to considerable wear and tear. It should also be observed that all these spines are a little out of true symmetry; that is, they are slightly bent to one side. The lateral deflection, moreover, is not always in one direction in different spines, but sometimes to the right and sometimes to the left. It has hence been suggested by Mr. Albany Hancock that the spines may not have been dorsal ones, as usually supposed, but paired spines, that were probably placed in front of the pectoral fins. Specimens of another spine have occurred, somewhat resembling *G. tuberculosus,* but differing from that species in having the concave border denticulated and bounded on each side by a plain or untuberculated area, as well as in being of smaller size. The authors have also found specimens of a large spine that appears to be identical with the *G. formosus* of Agassiz. Also examples of an Orthacanthus, about 12 inches long, and of a Pleurocanthus, 9 inches in length, and of another that seems referable to Leptacanthus. Besides these, there have been found some small spines that are smooth and slightly arched; they appear to belong to two species. Among the scales are, of course, those of *Megalichthys Hibberti.* They occur either isolated or in patches. Sometimes they are associated with the enamelled plates that cover the head of this fish, including the maxillary bones showing the teeth. Isolated scales of great size, belonging to a large Holoptychius, are not uncommon, as well as others that seem to belong to a smaller species of the same genus. There are also numerous small ganoid scales, in some cases with sculptured surfaces and serrated margins; some of them belong to a species of Platysomus, and others to Palæoniscus or Amblypterus, or possibly Eurynotus.

In some parts of the "blackstone" large quantities of small thorny tubercles are met with, which have evidently formed part of the dermal armature of a Placoidean, and from the way in which they are associated with the spines of *Gyracanthus tuberculosus*, they not unlikely belong to that fish.

A great number of maxillary bones, most of them with teeth, are among the fossils found at Newsham. Some of them, as we have already mentioned, belong to Megalichthys; others, as large in size, have been referred to Holoptychius and Rhizodus. All these maxillaries are armed with sharp-pointed, conical teeth, which are not easily distinguishable from each other when found detached. A fragment of another large maxillary, with the external surface irregularly and deeply pitted, and with large lancet-shaped teeth, has been found. Numerous smaller jaws, varying from 2 inches to ½ an inch in length, occur, and among them differences are to be observed, both in the character and arrangement of the teeth, that appear to indicate the presence of several distinct forms. One of these differs so strikingly from the others in its cylindrical, bluntly-pointed teeth, as to suggest the probability of it belonging to a reptile rather than a fish. Besides detached teeth of the maxillaries noticed in the preceding paragraph, the authors have also met with teeth belonging to Placoideans. Among these are two species of Ctenoptychius, which we doubtfully refer to *C. pectinatus* and *C. denticulatus. Diplodus gibbosus* also is not a rare form; and in one instance these teeth have been found connected with the bony plates to which they were affixed. Some very beautiful palatal teeth of Ctenodus and Ceratodus have also occurred, as well as others that seem to belong to Psammodus. Of more common occurrence than any of the foregoing fossils are various detached bones. Many of these are evidently cephalic bones, and such as belong to the thoracic arch. Vertebræ, too, are not uncommon, some of them being large and apparently referable to a fish the size of *Gyracanthus tuberculatus*, to which they probably belong. There is also repeatedly found in conjunction with the latter spine a large triangular bone, which appears to have been originally articulated.

Having now mentioned the various fragmentary remains of fish that we have found in the Newsham blackstone, we may add that the only fossils of the same class which have occurred in that deposit in a more perfect condition is a nearly complete example of a Platysomus, and another of a fish which we identify with Cæclacanthus. Both examples are small, the former being 3 inches long and the latter 4½ inches. Associated with these remains are large quantities of coprolitic matter; also large irregular masses of a substance showing a roe-like structure, that may possibly represent spawn or ova of some kind. The vegetable fossils that occur in the same bed are *Lepidodendron elegans, L. Sternbergii, Lepidostrobus* sp., *Calamitus nodosus, Bothrodendron punctatum, Sternbergia approximata, Megaphyton* sp.



STRICKLANDIA ACUMINATA.

Mrs. Strickland del.

The fossils we have noticed above have been derived chiefly from the Newsham pit; they have also been collected, to some extent, from the adjoining collieries of Cramlington, and they have been noticed in a lately sunk pit at Prestwick. At all these places the fossils are only found in the thin bed of black shale that lies immediately over the Low Main Coal.

NOTES AND QUERIES.

STRICKLANDIA ACUMINATA.—The *Stricklandia acuminata* was originally figured in pl. 2, fig. 2, of the 'Geology of Cheltenham,' by Sir R. I. Murchison, H. E. Strickland, and Professor Buckman; and there is also a woodcut from Professor Buckman's specimen on the title-page of the 'Memoir of H. E. Strickland,' and at page 167 of the Memoir, by Sir W. Jardine, Bart. The accompanying woodcut (Plate XX.) is from a specimen which was obtained by Mr. H. Strickland from Mr. Dewberry, Cheltenham, and being a much more perfect specimen, it is thought worthy of a fresh illustration.

The quarrymen found the fossil at Sevenhampton, and Professor Buckman's specimen most probably came from the same quarry, as the quarrymen said they found it in the Stonesfield slate-bed.

The leaf is imbedded in a hard sandy stone, and closely resembles the bed of stone called "Stonesfield Slate" at Stonesfield, which at Sevenhampton is at the base of the Great Oolite.

The leaf in form is very nearly identical with that of the existing *Salisburia,* the similarity of the two leaves striking any one at once when they are compared together.

BRITISH FOSSIL MAMMALIA AND FLINT IMPLEMENTS.—In the August number of the 'Geologist' you ask for any information concerning British fossil mammalia not hitherto recorded. I send, therefore, the subjoined list. All the specimens have been obtained from the Pleistocene deposits of Fisherton, Salisbury, since the publication of Mr. Prestwich's paper in 1855:—

Felis spelæa. Portion of lower jaw, with last molar *in situ.*

Hyæna spelæa. Nearly entire half of lower jaw, with all the teeth.

Canis vulpes. Portion of lower jaw, with teeth and portion of humerus.

Sus scrofa? Os calcis, only bone yet found.

Equus caballus. Both bones and teeth very plentiful.

Equus fossilis. Both upper and lower molar teeth of young individuals.

Bos primigenius. Bones and portion of horn case.

Bison priscus. Metatarsal bone.

Bison minor. Both metacarpal and metatarsal bones, not scarce.

Cervus Guettardi, or young of *Cervus tarandus.* Portion of shed antlers and bones.

Lepus timidus. Fragment of femur.

Lemmus Grœnlandicus? Teeth, jaws, and bones of several individuals. The portions of skull are too fragmentary to admit of a satisfactory comparison with the recent skeleton. Those portions which have been compared seem identical with the Orsinyak, or Greenland Lemming, in the British Museum.

Spermophilus. Undetermined species. Teeth, jaws, and bones of many individuals.

Although you ask for no information with regard to birds, it may be interesting to some of your readers to know that fragments of two specimens of such fragile things as birds' eggs have been obtained from the same deposits: one, in point of size and thickness of shell, would correspond, if entire, to that of a goose; the other to that of a moor-hen.

I also wish to place upon record the finding of a very perfect and characteristic flint-implement in the "higher level gravel" of Fisherton, on Monday last. It is pretty evenly stained of a pale ochreous yellow, and bears evidence of having had some rough knocks from its travelling companions. This is the first example found, after a patient search by myself and others of nearly five years. Surely, after this, brother-geologists need never despair of finding flint-implements, although, like myself, they may be often heartily tired of bootless expeditions.—Yours very truly, H. P. Blackmore, M.D.

Salisbury, September 17th, 1863.

[We have received a drawing of the implement.—Ed. Geol.]

Mammalian Remains in Russia.—The following are translated notes from Georgi's Hist. Nat. Russia, vol. iii.:—I. Decayed human bones, found in the graves of former settlers, together with metallic vessels, also with remains of burnt corpses; for instance, on the Yenisei, near Krasnojarsk, in Dauria; on the Ingoda; in the Ural and Kolywan mountains, in the mines of the ancients. Dried human bones, partially petrified, are found in lime- and chalk-pits near some river-banks in Podolia (Guetard); on the Swiaja of the Volga, on the brook Birjutsch, in clay (Lep.); on the Ik of the Kama, in sandy mountain-green.

Exhumed elephant-bones, *R. momotowa* (Kosti), mammoths' bones, skulls, jawbones, fangs, dorsal vertebræ, shin- and hip-bones, have been found in Russia, and especially in Siberia, for ages; and they were considered as the bones of a monstrous kind of animal, living under the earth and dying by contact with the air, and which very likely might have been the Behemoth of Job. The Russian academician, M. Du Vernoi, showed first that these bones belonged to elephants. When, in accordance with the order of Peter the Great, in 1722, all fossil and other curiosities were sent to the Imperial Museum of St. Petersburg, everybody considered these bones to be curious; and examples were thus brought there, together with other fossil bones, from many districts of Russia, in such abundance that they speedily filled the extensive vaults of the museum. In the greater part of the Siberian, and in some of the Russian rivers, they are washed out from their loosened clay, marl, lime, and sand, and earth of the shores. They are more or less efflorescent, soft, partly earthy,—some of them falling to pieces,—greyish, whitish, bluish; and some hard, and of a fresh appearance; and those are especially well preserved which occur in the Arctic swamps (*tundra*). For the most part these bones were found scattered singly, but sometimes also there were many together, although but very seldom whole carcasses occur. The museum now receives them but very sparingly, as they are less cared for.

II. On the bones, and places where they were found. 1. In Russia. Many elephant-bones, on the right bank of the Don, near Kostizi; on the Volga, near Kusmodimjarsk; in the chasms near Nischnii Nowogorod; on the Swiaja of the Volga, on the bank of the brook Birjutsch (Lep.; Pall.); on the mouth of the Swiaja; on the bank of the great Irgis, on the left of the Volga. An elephant molar tooth on the shore of the White Sea, also on the Dwina. Elephant-bones, in Permia, on the bank of the Babka; the Sylwa, near the foundry of Jugewskoi Sawod; one 9 feet long; on the Meschowaja Utka of the Tschussowaja, near Wisimo Utkinskoi Sawod, where they have been discovered in an argillaceous bed in digging for a dam; on the Ik of the Kama; on the bank of the Ufa, the Belaja, the Dioma, and in the Belaja itself, as well as in many Kama rivers of the Government of Kazan. (Kanz.) 2. In Siberia. Exhumed elephant-teeth and ivory in many places of the eastern or Siberian Ural (P.). Elephant bones, on the right bank of Ural river, near Kalmukowa (P.); on the lower Tura, and ports in many places; on the Neiwa of the Tura; on the banks of the Winokurka and Suworifch of the Iset (P.). Greatly-destroyed elephant-bones of a bluish and blackish colour, in the bluish sand-marl, on the Atasch of the Iset, near Taimilskaja Sloboda (P.). An elephant jaw-bone, with glossopetræ, on the bank of the Tura, noticed by Haller; another with ammonites from another place in Werchoturean Ural, was sent to the Academy by Councillor Tatischew. An elephant-tooth was found in the gold mountain of Beresow, 6 feet below the surface, in clay; and Hermann considers this the highest place where these bones are found; the banks of the upper Yenisei seem, however, to be far higher. Elephant-bones, in many places of the banks of Tobol. Rotten, bluish elephant-bones and teeth, on the bank of the Ischim, near Petri Pawloskoi Krepost, also on the Karasu and Wagran of the Ischim. An elephant-tusk, 10 feet long, from the bank of the Ischim (P.). A hip-bone, 48 poods weight,* on the bank of the Irtysch, near Oresk (P.).

Elephant-bones, in many places on the bank of the Irtysch, over Omsk; in the Kolywan, on the bank of the Alei of the Ob; in the high sand-banks (left) of the Ob, near Obdorsk (Suj.); in the Baraba, on the clay-bank, in clay (P.). A rather rotten hip-bone in the Tom-Tschumysch (right) of the Ob, where it was discovered in digging for a dam (G.); in many places on the banks of the Tom. An elephant-tusk 5½ feet long, on the Yenisei, near Krasnojarsk (Messerschm.); on the lower Yenisei, 620 versts* below Turuchansk, near Salakino Simowie, at the head of the gulf. Elephant-bones on the Angara and the Upper Tunguska (Comment. Petrop.). An elephant-skeleton, with a skull weighing 152, a tooth weighing 160, and a thigh-bone weighing 25 lb., on the Wilvi of the Lena (Messersch.); in many places on the banks of the Lena; on the Argun, in Nertschinsk; on the rivers of the Polar Sea, Chatanga, Indigirka, and Kolyma, also on the Anadyr of the Baltic Sea (Comment. Petrop.); in the Arctic turf-fields on the Gulf of Kariss of the Polar Sea (Suj.); in the environs of the Lena and Wilvi, on the lower Indigirka, and many other places (G.).

A rhinoceros-skull was discovered in the Obstschei Syrt above the Schesma, others in many of the Kazan rivers.

A rhinoceros-skull on the Ob, near Obdorsk, in Siberia; on the Tschitoi of the Selenga, in Dauria; on the Kinga rivers in Irkuzk, 30 versts of Irkurzk (Laxm.); in the turf-fields (*tundra*), near the Lena (Gm.); on the Lena, near the Swestoi, 200 versts of the ice-sea (Gm.); on the Anadyr, in turf-fields (P). A rhinoceros-skull with two horns on the bank of the Indigirka, near Saschiwersk, where also two nose-horns without the skull were found.

A rhinoceros-head, with uncorrupted, partly still bloody and uninjured skin, was discovered a few years ago on Wilvi of the Lena, in a frozen turf-field (*tundra*), not very deep under the grass. The body was not found; it may perhaps be still lying in some other place of the ever-frozen marshes, or perhaps it may, on its being embedded, not have been sufficiently covered against the action of the atmosphere, and thus the other part has rotted away. The head had not any nose-horn, and it could not be made out how the fleshy head had been separated from the carcass. In the open air its odour was very offensive, and it was only after undergoing a process of drying nearly approaching the first stage of carbonization that it was possible to place it in the museum.

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* A pood = 40 lb.

† A verst = six furlongs.

The museum contains five other rhinoceros-heads and five horns from various not precisely indicated places in Siberia.

Ox-skulls, and bones of a still unknown species, on the bank of the Swiaja, on the right, and of the Irgis, on the left of the Volga (P.).

Ox-bones, on the bank of the Ural river, near Walmukawa (P.), and on many places of the same bank (Steller, Pallas).

Ox-skull, on the Ob, near Obdorsk, where also bones were found (P.); on the Miäs of the Iset of the Tobol; on the Tura; on the Oi of the Ural river, in the steppes of Kirgis; on the Wilvi of the Lena; on the Tunguska of the Yenisei; on the Kuda of the Angara; on the Ilga, near the Ilginskoi Ostrog, on the Lena; on the Anadyr of the Baltic Sea; and in many places of Siberia (Nov. Com. Petrop.).

Bones, perhaps of a hippopotamus, on a branch of the Belaja of the Kama (P.).

Morse-teeth, in the arctic turf-fields of the Polar Sea, in many places pretty abundantly, and so fresh as to be used for ivory, and forming a branch of commerce.

An exhumed morse-tooth, 8½ lb. weight, on the Gulf of Penschia; another, weighing 5½ lb., on the Kamtschatka (P. Nord. Beitr.).

A bluish-tinged tooth, on the mouth of the Tagil (P.).

Exhumed whales' bones, on the bank of the Yenisei, near Kanditu Nos, also on the bank of the lower Lena (Gm.).

An exhumed twisted narwhal- (unicorn) tooth, on the lower Indigirka, near the Udjadinskoi Simowie, near the Anadirskoi Ostrog, in a moor. The museum possesses also an exhumed narwhal-tooth from the middle of Siberia.

Bones, transformed into limestone, were dug up on the Ischova, near Gatschina, 9 feet deep (Model).

In the striated limestone on the right bank of the Volga, near Saratow, hardened bones.

Bones with petrified wood, on the Lariwonicha of the lower Tunguska (Messerschm.).

Exhumed antelope-horns, at present known as an African animal, from Siberia (Pall.).

Errata.—Page 205, line 16, for "to be able" read "to have been able;" page 205, line 24, for "rocks" read "rock;" page 205, line 11 from bottom, for "there" read "here," that is, in Trinidad; page 205, line 5 from bottom, for "Brown" read "Bronn;" page 207, line 7, for "Astrea" read "Ostrea."

FOREIGN INTELLIGENCE.

Under the title of 'Considerations on Professor G. Capellini's Lecture on the Antiquity of Man,' Dr. L. Forresti has printed, *at Bologna*, the following remarks, which we translate from the Italian pamphlet:—

Three years ago, Professor Capellini, in one of his lectures on geology, alluding to the most recent discoveries made in the lakes of Switzerland

and at Abbeville, maintained that men lived contemporaneously with the cave-bear and other animals whose remains are found in caverns, and urged the necessity of further studies, especially of the crania discovered by Schmerling in Belgium.

In his professional course of the past year he again briefly touched on this topic, and during the present year has expressed his delight with the important writings of Lyell and Huxley,—reminding his audience that it was not since the publication of those works, but long before in the Italian University, that he had supported these ideas which are now so rapidly gaining ground, and had predicted the results now attained.

In his lecture referred to, the Professor gave an historical sketch of the pretended and true discoveries of fossil human remains, commencing with the fossil bones discovered at Chaumont in 1613, and attributed to the Cimbrian king Tetobochus, about which M. Mazurier, surgeon of Beaurepaire, speculated for a time; they were next transferred to the museum at Bordeaux as human bones, where De Blainville afterwards readily recognized them as belonging to a proboscidian animal. Then followed the story of the *Homo diluvii testis* discovered by Scheuzer, which, according to Grunner, in 1773, proved to be nothing more than a skeleton of a gigantic salamander; then that of the fossil man discovered at Fontainebleau, in 1828, which was found to be but a mass of fragments of *Arenaria conglutinata* sand, simulating the form of a horse and horseman; and so on, through various facts and fictions, to the discoveries of M. Boucher de Perthes in the environs of Abbeville, and the results obtained from researches since 1856 amongst the pile-works of the lakes of Switzerland, and those in the Italian lakes, especially in the Lago Maggiore, by M. Desor; also those in the peat and turf deposits and sea-shores made by Gastaldi, Moro, Strobel, and others.

Analysing Lyell's work, he showed how, by means of fresh observations on the remains in the Belgian caverns, the laws of progressive development and the origin of the species by variations are supported. In fact, Lyell and Huxley, by a comparison of the fossil crania found at Neanderthal and Engis, with those of the chimpanzee, the gorilla, and others, have been enabled to fix the relationships and the differences which exist between the present races of man, fossil man, and the various species of anthropoid apes.

From these studies, and those of Morlot, we are tolerably certain that fossil man is to be found in every post-tertiary deposit, and that the frequency of his relics sensibly diminishes the more remote the epoch; the same fact is likewise verified by the dog, the cow, and other animals, which were the earliest companions of man.

The Belgian or Engis man was contemporary with the cave-bear, but the Düsseldorf or Neanderthal was unlike the first, and showed such an analogy of structure with the pithecus, that at first sight it could hardly be believed to belong to the human genus. According to the theory of the origin of species by variations, it must necessarily belong to an epoch far anterior and difficult to calculate. Between the Belgian and the Düsseldorf man the Australian type ought to be intercalated.

Admitting these truths as confirmed by facts, we are still far from a certain knowledge of the species which ought to unite the anthropoid apes with the human species, although the question seems now to be nearer a solution, by the discovery of the Neanderthal cranium, which Professor Schaffhausen justly declared to be of all the human fossils the one which approaches most nearly to the ape; and close examinations have led to the conclusion that between the Neanderthal man and the gorilla, if judged by the capacity and form of their crania, there is less difference than exists between the former and the European race.

If we wish to establish the relation between man and the inferior animals we must necessarily admit, according to our Professor, that between the Neanderthal man and the more elevated type of the great family of apes, the Catarhines, or tailless, there is less difference than is seen between the inferior link of the Catarhines and the more elevated Platyrhines, or those with tails, and of which we ignore the transition species. We must, therefore, admit with Huxley, that the human species forms a natural family which can now be called the Anthropini, a family which is connected with the Catarhines in the same way as the latter is united with that of the Platyrhines, forming thus a superior group in the zoological scale, that is the Primates, a classification already adopted by the celebrated Linnæus.

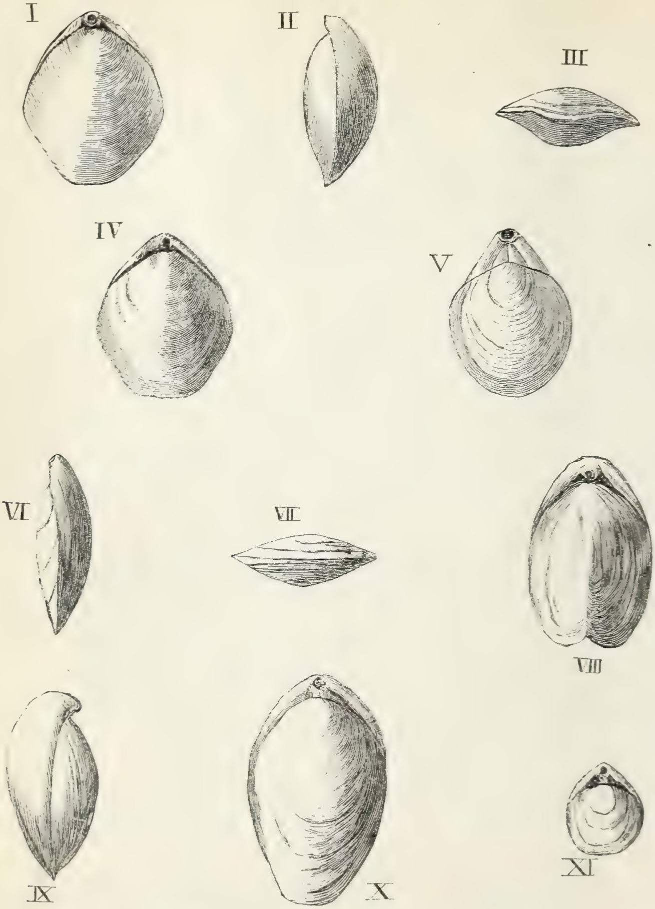
For geologists and palæontologists, therefore, there is a large field opened for research, and it will be their duty to endeavour to fill up the gaps and to find out the connecting links between the Anthropini and the Catarhines; and for this purpose we must turn our regards towards Central Africa, the islands of Sunda, Borneo, and Sumatra,—that is, towards the regions where the anthropoid species are chiefly developed, and there not in the recent formations but in those of the Tertiary period,—not confining ourselves to the Pliocene, but descending to the Miocene, and perhaps even to the Eocene.

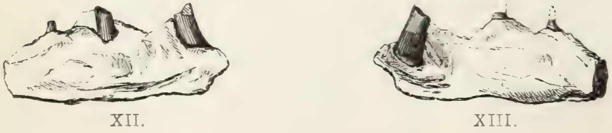
These were substantially the subjects treated by the Professor, and of which Dr. Forresti had proposed to give an account at a time when the Professor himself gave an appendix to his former remarks in one of his subsequent lectures on fossil man, referring to the jaw discovered on the 28th of March, at Moulin-Quignon, near Abbeville, in the diluvial strata already alluded to, informing his audience at the same time of the many questions that had arisen on the subject, as well as of the meeting of the distinguished French and English palæontologists and geologists at Abbeville, in April, and of their mutual acknowledgment of the authenticity of the jaw, a drawing of which, sent him by the discoverer, was exhibited by the Professor.

This rapid succession of researches and discoveries induces great hopes for the progress of these studies.

M. Virlet d'Aoust asserts that the ophite of the Pyrenees is not an eruptive rock, but a metamorphic sedimentary rock; that it belongs to the Trias formation, and represents, with the gypseous and saliferous marls, the age of the Muschelkalk. Without resting content with isolated facts, M. d'Aoust proposed to assure himself whether, supposing the ophite to be a metamorphosed rock, its recognized position at Leez would not be its normal position. It remained to verify this, and he was agreeably surprised to find in the Barousse,—the *massif* of the mountains which separate the Haute-Garonne from the Hautes-Pyrénées,—exactly in the direction of the sections of Cierp, of Leez, of the Col de Mendé, the same succession of rocks, and to see the ophite, not only in the identical position, but also there elevated in the planes of the other rocks in natural order.

PLATE XXI.





CRETACEOUS TEREBRATULÆ. Figs. I. to XI.

I. II. III. T. Moutoniana, *D'Orb.*—English specimens, Shanklin.
IV. T. Moutoniana, *D'Orb.*—French specimen.
V. VI. VII. T. depressa, *Lam.*—Shanklin.
VIII. IX. T. Celtica, *Morris.*—Variety, Shanklin.
X. T. Celtica, *Morris.*—Shanklin.
XI. T. tamarindus, *Sow.*—Shanklin.

PACHYRHIZODUS GLYPHODUS, n.s., Blake and Mackie. Figs. XII., XIII.

THE GEOLOGIST.

NOVEMBER 1863.

BRITISH EARTHQUAKES.

By the Editor.

England has been visited by an earthquake. The newspapers have dilated upon it, and hundreds of persons have hastened to record their sensations. They have told us how they got out of bed and lit their candles, as if they had hoped to have seen the earthquake, like a ghost, wandering about the earth; but earthquakes do not linger, and the last British one was over before most people knew anything about it. Others fancied they heard a great roaring noise; others compared the shock to a great dog or animal shaking itself under the bedstead; others to the vibrating of a steam-engine. Some saw leaves fall, walls shake, and some felt "a warm breath of air" upon their cheeks. In short, some told the truth as far as they could, and some told what was not quite the truth. If the truth had been simply stated, and the press had helped to state it by publishing as many letters as their correspondents chose to send them, we should have no other comment to make than to have thanked it for its pains. But when leaders were printed in such terrible paroxysmal terms, thanking Heaven we were not all swallowed up, we can scarcely regard such sensation articles as little less than impious. Earthquakes are of the most common occurrence, and science wants cool observations whenever they happen. No doubt they are, when their visitation is severe, amongst, if not *the* most awful of all catastrophes. To have a whole city thrown down in an instant, and thousands of suffering human beings crushed and lingering in agony beneath the ruins, is indeed a frightful scene, upon which the mind refuses to dwell. But where one earthquake assumes this fearful condition, hundreds, if not thousands, pass away as mere harmless, or nearly harmless, tremors. British earthquakes are by no means uncommon, as the following list will show, beginning with the earthquake recorded in A.D. 974, on the authority of Simon Dunelmensis. Then follow in succession—1043, stated in the 'Courrier Français' of March 27th, 1843. 1048, in 'Rerum Anglicarum Scriptores,' fol. 51, felt in Worcester, Derby, and many other parts. 1076, on the 26th of March, recorded by Matthew of Westminster, lib. ii. p. 6, as throughout all England, accompanied by subterranean noise; and more shocks were felt on the 6th and 22nd of the following April. In 1085, noticed by Lycosthenes. In 1089, Aug. 11th, at the third hour of the night, by Simon Dunelmensis, who says houses were seen to leap upwards and return to their positions, and that the harvest was not got in until the end of November in that year. 1099, on the 3rd of November, by Roger de Hoveden, in Rerum Anglic. Script. fol. 268. 1105, at Ely, noticed in the 'Gentleman's Magazine' for 1750. 1110, an earthquake lasting from morning to the third hour of the day, at Shrewsbury and Nottingham, is recorded by Simon Dunelmensis, after the Shropshire Chronicle of Henry de Knyghton,—the bed of the Trent is asserted to have been laid dry for a mile in length, so that it could be passed with dry feet. 1112, in partibus Britanniæ, Dom Bouquet, t. xii. p. 557; 1115, in Italy, and said to have been felt in England. 1117, Dec. 10th, in the middle of the night: Matthew of Westminster says the moon appeared the colour of blood. 1119, Sept. 28th, at the third hour of the day, in different parts of England, Simon Dunelmensis. 1133, Aug. 4th, in the morning, a very violent earthquake, preceded by very loud subterranean noises, is noted by Matthew of Westminster, Matthew of Paris, Polydore Vergil, and Simon Dunelmensis. 1134, on the coasts of England and the Netherlands, the sea rose suddenly with such violence as to inundate the country, and retired to its usual level as suddenly: no land shock felt. 1142, at Lincoln, three shocks on the same day, Simon Dunelmensis. 1158, London and other places. Thames dried up so that persons could pass; very violent in Syria,—recorded in Gervais' Chronicle. 1165, at Ely and in Norfolk and Suffolk; Matthew of Westminster says persons were thrown down, and the bells made to ring. 1179, near Arlington, Durham, ground swelled up and sank again with great noises,—possibly a local phenomenon. 1180, about the 29th Sept., two or three shocks are noted by Simon Schard and Lycosthenes. 1185, about April 16th, all England, especially at Lincoln, in which the cathedral and many other buildings were overthrown. 1186, after the middle of September, universally throughout Europe, especially in England, where houses were thrown down, and in Calabria and Sicily, where many towns were ruined, recorded by Matthew of Paris and Matthew of Westminster. 1199, principally in Somersetshire, persons thrown off their feet: Ymagin. Hist. Radulfi de Diceto, col. 709. 1201, Jan. 4th, York and neighbourhood, accompanied by noise; another shock on the 22nd May, at the sixth hour of the day, in Norfolk. 1202, in different parts of England. In the winter of 1218. 1219. 1221. 1246, June 1st, at the ninth hour, especially in Kent. 1247, on Feb. 13th, different parts, especially London. 1248, Dec. 21st, Bath and Wells (also in Piedmont, Savoy, and Syria), the summits of the cathedral of Wells being much shaken, whilst the foundations were not. 1250, at St. Alban's and Hertford, accompanied by subterranean noise; pigeons and other birds frightened. 1274, Dec. 5th, throughout England, accompanied, according to Matthew of Westminster, by thunder, lightning, a comet, and a fiery dragon; and, in the Pays-de-Galles, according to Polydore Vergil, by a rain of blood. In the September of the following year (1275), between the first and third hours of the day, Matthew of Westminster says many of the most famous churches in England were thrown down or injured; among others, that of St. Michel-du-Mont, near Glaston. 1278, in France and England. 1284, in England. 1298, Jan. 5th, at twilight. 1318, Nov. 14th. 1320. 1385, July 16th, at night, followed by another earthquake during the same year. 1426, throughout all Great Britain, the shocks, preceded by a dreadful tempest, lasting for two hours, recorded in Stow's 'Annals.' 1551, at Reigate, Croydon, Dorking, in Surrey; kitchen utensils and other movables, thrown from their places, noted in Strype's Memor. Eccles. In 1574, Feb. 26th, very violent in the central counties, from Bristol to York, occurring between 5 and 6 P.M.; it is recorded also at Gloucester, Bristol, Hereford, and neighbouring counties; at Tewkesbury and some other places, plates and books were thrown from their places; the people who were on their knees in the chapel of Norton were almost all thrown down, and the bell in the Market House of Denbigh sounded two strokes. 1575, Baker, in his 'English Chronicle,' says the Thames ebbed and flowed twice in an hour. 1580, April 6th, at 6 P.M., throughout England, especially at London, Dover, and the whole of Kent; also in France, in Belgium, Zealand, and Holland; most violent in England, lasted about a minute; two other shocks were felt in Kent, at 9 and 11 P.M.; at Sandwich and Dover, vessels dashed against each other in the harbours, the great bells of Westminster sounded, and portions of buildings and chimneys were thrown down in London, the sky clear and the air tranquil; another shock on the 1st of May in Kent, strongest at Ashford, occurred also in the Netherlands and as far as Cologne. 1583, landslip in Dorsetshire. 1597, shocks at Perth and other parts of Scotland. 1609, flux and reflux of the tide twice in an hour. 1638, at Chichester, several shocks did great damage; stated in the 'Dresdner Gelehrte Anzeiger' of 1756 to have been accompanied by the smell of pitch and sulphur, and that the atmosphere was obscured, as if by a cloud. 1657, July 8th. 1661. In 1666, at Oxford, Stanton, Coventry, etc.; and in Hungary rocks were cleft in pieces. September, 1671, on coasts of English Channel and German Ocean, and from St. Malo as far as Antwerp. 1677, Wolverhampton. 1678, Jan. 5th (new style), 8 A.M., on borders of Derbyshire, supposed direction E. to W.; and a second at 11 P.M., in Staffordshire, S. to N., preceded by subterranean noise, recorded in Plott's 'Staffordshire;' another on 20th Oct., at same places, at 11 P.M., preceded by loud noise, like prolonged thunder; at Brewood, etc., Nov. 14th, at 11 P.M., N. and S., repeated three times before 2 A.M.; Nov. 15th, less violent. 1680, Jan. 4th, 7 A.M., in Somersetshire and the country round; air calm; shock accompanied by a noise like a sudden gust of wind. 1683, Sept. 28th, at 7 A.M., Oxford, Berkshire, Buckinghamshire, and the shocks recorded at 4 A.M.; a man who was fishing in the Cherwell perceived the boat to tremble under him, and the little fish showed signs of alarm; accompanied by a low noise like prolonged thunder; weather wet to 20th, became fine on evening of 27th; a tin vessel thrown down; another, Oct. 9th, Oxford, north to Derbyshire, feeble at former, violent in latter county. 1688. 1690, Oct. 17th, Ireland; Dec. 18th, middle of night, in Bedfordshire and Scotland. 1691, Deal, Canterbury, Sandwich, and Portsmouth, said to last six minutes. 1696, Falmouth. 1704, Jan. 8th, most violent at Lincoln, N. and S., accompanied at Hull by a noise like the sighing of the wind, though air perfectly calm, doors and furniture set in motion, and chimneys thrown down. 1712, Shropshire, said to have been very violent. Another in

1726, Nov. 6th, about 6 A.M., at Ilchester (?), a rather violent shock, according to the 'Gazette de France' of 30th Nov., the same shock being seemingly felt in the north of Iceland, accompanied by an eruption of Krabla. 1727, Oct. 4th, Naples and England. 1731, Oct. 19th, Northamptonshire, accompanied by a noise like distant thunder (Phil. Trans. vol. x. p. 249); Oct. 21, at Bloxham, Barford, Banbury, etc., when windows were violently shaken, followed one minute after by brilliant lightning at Aynho; the day after, the sky appeared the colour of earth. 1734, in Sussex, and in France, at Havre, and as far as the other side of the Seine; atmosphere quite calm, weather became suddenly cold just before. 1736, Ochil Hills, in Scotland, accompanied by subterranean noises. 1748, July 12th, between 10 and 11 P.M., Somersetshire and English Channel, to the Severn, the shock appearing to come from a distance, accompanied by a noise like that of a waggon in motion. 1750, at Eltham, in Kent, about half an hour after noon; ten minutes later a violent shock is recorded in London, where there were other shocks on 19th March; in the 'Philosophical Transactions' chimneys are said to have been thrown down, and that the earth in St. James's Park seemed to swell up ready to open, and that fishes threw themselves out of the water; other shocks are recorded at various places on March 29th and April 13th, and at Wimbourne, Dorsetshire, on May 15th, and in Lincolnshire and Nottingham on Sept. 3rd, and in those and other counties, including Suffolk, on Oct. 11th. 1751, March 31st, Somersetshire. 1752, April 16th, Somersetshire. 1753, June 8th, Cheshire; July 18th and Sept. 26th, various parts. 1753, March 25th and 27th, at York, on the latter occasion (10 to 11 A.M.) large masses of rock were thrown down, and the surface of the ground disturbed. 1754, April 19th, at York. 1758, April 28th, Middlesex, and Mediterranean; Aug. 1, Northamptonshire. The 1st of November, 1755, was the day of the great earthquake of Lisbon; sensible shocks were felt in England only in a few places.

To continue our list—1755, Nov. 17th, in Cumberland and Herefordshire; Nov. 18th, Herefordshire; Dec. 18th, Herefordshire; Dec. 31st, Glasgow and other places in Scotland. 1756, at 7½, P.M., west of Ireland, preceded by an aurora; Feb. 13th, Middlesex and Kent, in connection with shocks in the Alps, Germany, and France; Oct. 17th, Argyleshire; Dec. 26th, Cornwall. 1757, July 15th, Scilly Islands and Cornwall. 1758, Sussex, Surrey, and Kent; Dec. 20th, London. 1761, June 9th, Sherborne, Shaftesbury, around for thirteen miles. 1762, March 16th, Wexford; March 20th, Shaftesbury, Dorsetshire. 1766, Jan. 10th, Glamorganshire. 1767, April 20th, west of Stirling, Scotland. 1768, Jan. 3rd, Northamptonshire; March 15th, Newcastle, Manchester, and Yorkshire; Dec. 21st, Worcester, Gloucester, etc., and in mountains of Scotland; Dec. 29th, Herefordshire. 1769, Nov., Inverness. 1771, April 29th, Berkshire; Aug. 24th, Cheshire. 1773, April 15th, Dorsetshire, in connection with St. Malo, Guernsey, Jersey. 1775, Shropshire. 1776, Oct. 28th, Northamptonshire, Leicestershire, etc.; Nov. 27th, Kent, also at Calais; Dec. 24th, Inverness. 1777, Sept. 14th, Lancashire, Derbyshire, Cheshire, Yorkshire, etc. 1780, August 29th, Anglesea, Caernarvon, etc., with noise like waggons; slight shock at Lisbon; Dec., North Wales; Dec. 18, Newcastle, York, Leeds, etc. 1782, Oct. 5th, Flintshire, etc., rather violent. 1783, April 23rd, Colebrookdale; Aug. 9, Cornwall. 1784, Dec. 6th, English coasts. 1784, south of Scotland, Isle of Man, and Dublin. 1786, at Lancaster, in Cumberland, at Newcastle, Glasgow, and Isle of Man—with rumbling noise. 1787, July 6th, Cumberland. 1788, July 8th, Isle of Man,—the sea suddenly receded at Dunbar. 1789, May 5th, Devonshire; Sept. 2nd, Perthshire; Sept. 26th, Shropshire; Sept. 30th, Edinburgh; Nov. 5th, Cromarty and Crieff; Nov. 10th and 11th, and Dec. 29th, at Comrie, Perthshire. 1790, Armside, in Westmoreland, violent, accompanied by an explosion louder than thunder; at daybreak two clefts were found in the earth, one of which was very deep and two hundred feet in length. 1791, Sept. 2nd, Comrie, Perthshire; Oct. 28th, in England. 1792, Feb. 25th, Lincolnshire; March 1st, Bedford, Leicester, Lincoln, Nottingham, etc., rather severe, tremulous motion; Nov. (?), Comrie, Perthshire. 1793, Sept. 28th, Salisbury and Shaftesbury. 1795, Comrie, Perthshire; Nov. 18th, from Leeds to Bristol, and Norwich to Liverpool, S.W. to N.E. 1796, Oct. 23rd, Ripon. 1799, Jan. 17th and Feb. 24th, Comrie, in Perthshire. 1801, June, Chester and neighbourhood; Sept. 7th, whole of Scotland—the centre seemingly at Comrie, Perthshire. 1802, Oct. 26th, Caermarthen, in Wales. 1805, Jan. 12th, Valley of Clwyd, North Wales; March 21st, in England. 1809, Jan. 18th, Dunning, Perthshire, preceded by subterranean noise, like thunder. 1812, Jan. 18th, Oxfordshire; May 1st, Gloucestershire, accompanied by a noise like thunder; Nov. 13th, at Portsmouth, a violent shock during the Caraccas earthquake. 1813, Sept. 24th Stamford, Peterborough, etc. 1816, March 17th, Sheffield, Nottingham, Lincoln, Derby, etc., accompanied by a noise like a rising tempest; Aug. 13th, Inverness and country around for a hundred miles, centre of disturbance apparently Inverness-shire. 1817, June 10th, 16th, and 30th, Inverness and neighbourhood; also Aug. 7th, at Urquhart, and Sept. 2nd, at Inverness; Nov. 9th, Yorkshire, Westmoreland, and Lancashire. 1818, Feb. 6th, Coningsby, in Lincolnshire, and country around; Feb. 19th, Aberdeenshire; Feb. 20th, Inverness, at 1.20 P.M., and Coningsby, etc., at 3 P.M.; April 19th, a smart shock, extending from Lincolnshire across Yorkshire; June 9th, Loch Awe, Scotland; June 19th, Comrie, Perthshire; September, Inverness; Oct. 31st, at Dalton, Lancashire,—a dreadful shock occurred in Ireland on the same day; November 11th, Inverness and around, with noise like thunder, bells rang; Dec. 7th, Bangor and Penter, North Wales. 1819, Feb. 11th, Ballenloan, in Glenlyon, Scotland; Nov. 28th, Comrie; Dec. 4th, Amabree, in Scotland. 1820, Comrie and Dumbarton, etc.; a strong earthquake of three shocks, Loch Lomond waters were agitated; April 6th, Cork and neighbouring towns; April 11th, neighbourhood of Cork, both accompanied by rumbling noise; May 20th, Wanlock Head, Dumfries; Sept. 27th, Barmouth, in Merionethshire; Nov. 28th, Leadhills and Wanlock, Scotland, and around for 10 miles E. and 5 miles W.; also Nov. 29th. 1821, Oct. 9th, Stratheam, near Crieff, Scotland; Oct. 22nd, Comrie, Crieff, etc.; Oct. 29th, Glasgow, etc.; Nov. 27th, Leadhills and Wanlock Head. 1822, Feb. 20th, near York; April 13th, Comrie; April 18th, Crieff and neighbourhood; Sept. 18th, near Newcastle-upon-Tyne, severe, accompanied by noise like thunder. 1824, Dec. 6th, Portsmouth and south coast of England. 1826, Dec. 25th, Loch Erne, and at Leadhills, Scotland. 1827, Feb. 9th, Anglesea, North Wales, and at Ripon, in Yorkshire. 1829, Dec. 9th, Comrie. 1831, March 1st, Perthshire; March 2nd, Kent and south-east coast, at 8 P.M., severe shock, windows rattled sharply.* 1832, Dec. 30th and 31st, Swansea, etc., in South Wales. 1833, March 20th, Glengarry, Inverness-shire; Sept. 18th, Dorsetshire; Nov. 13th, Chichester. 1834, Jan. 23rd, Chichester and south coast, etc.,—the point of greatest intensity seemingly a few miles N.W. of Chichester; Aug. 25th, in Perthshire; Aug. 27th, along Hampshire coast, etc.; Sept. 21st and Oct. 5th, at Chichester—severe on the latter date, the earth trembling for two or three minutes; again, a slight shock on the 12th January, 1835, during which year also were shocks at Liverpool and other places in Lancashire on the 23rd Aug. In 1836, April 4th, in Shropshire. 1837, Oct. 20th, Cornwall and Devonshire. 1837, Oct. 27th, at Camelford, in Cornwall, severe shocks accompanied by a dull noise; Nov. 27th, another shock; Dec. 8th, at Stamford, in Lincolnshire, and twenty miles around. 1838, Jan. 14th, at Tynehead, in Northumberland,—the shock of sufficient force to throw down articles of furniture; the next day a rent was observed in the fields more than half a mile in length, "supposed to have been caused by the earthquake;" March 17th, Shrewsbury and neighbourhood,—an alarmingly vibratory shock, accompanied by a rumbling noise like a train of waggons,—bells rang; July 30th, Tureff, in Scotland; Sept. 14th, Adderbury, Oxfordshire; Dec. 23rd, Charnwood Forest, Leicestershire, with rumbling noise. 1839, March 20th, Glengarry, in Inverness-shire; May 10th, at Bridgewater; May 24th, Glasgow and Crieff; June 11th, north of Manchester; June 12th, Lancashire and north of Manchester; Sept. 2, Bristol, Newport, Cardiff, and South Wales; also at Shrewsbury,—felt most at King's Down,—severe; Sep. 10th, Monmouthshire,—severe; Oct. 23rd, over two-thirds of Scotland,—Comrie being one point of intensity; also numerous shocks occurred at Comrie constantly during the whole of this month; also, Nov. 24th, in Dorsetshire. 1840, Jan. 8th, Donegal; Jan. 31st, Feb. 29th, March 23rd, April 30th, July 31st, Aug. —, Sept. 9th, Oct. 31st, Nov. 29th, Dec. 31st, at Comrie, Perthshire. 1841, Jan. 31st, Caermarthen, etc., Wales; April 19th and 21st, Oban, in Argyleshire; Dec. 20th, Kintail, Scotland, and at Comrie, 6th, 18th, Jan. 31st, Feb. 26th, May 30th, April 13th and 30th, March 23rd, June 30th, July 2nd, 23rd, 25th, 26th, 30th, and 31st, Aug. 1st, 10th, 12th, 25th and 30th, Sept. 8th, 9th, 10th, 16th, 17th, 19th, 22nd, 23rd, and 29th, Oct. 5th and 23rd, Nov. 3rd, 5th, 6th, 7th, 8th, 18th, and 26th, Dec. 3rd, 6th, and 7th. 1842, Feb. 17th, in Cornwall; June 21st, in Lancashire; Aug. 22nd, in North Wales,—said to have been detected instrumentally at Prague. And at Comrie, Jan. 2nd and 7th, March 10th, April 21st and 22nd, June 1st, 2nd, 8th, 23rd, July 1st and 10th, Aug. 27th, Sept. 2nd, 24th, 25th, Nov. 18th and 29th, and Dec. 4th and 17th.

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* The writer remembers this distinctly.

The above account of British earthquakes is abstracted from Mr. Mallet's elaborate general list, published in the Reports of the British Association, which goes up to 1850, since which date many shocks have been felt, especially one in 1852, through

Shropshire, Leicestershire, Cheshire, and generally over the same area as the one a few weeks since. Our list is, however, if not quite perfect, sufficiently complete to show how numerous, even in England, earthquake-shocks are, and how generally not dangerous nor violent in their effects. To establish this point was not our purpose in this article, but rather to raise discussion on an important question. All earthquakes are more or less of the nature of what are properly termed "shocks," and more commonly they are the effects of something *sudden*, more like the snap of a bar of metal or stone under tensile strain than an explosion of gunpowder or gases. Perhaps very generally they are the "shocks" of the rupture of masses of dense strata, or the sudden slippings of one great rock-formation over another. We ourselves pay little regard to the idea of a central fused mass, and the possibility of tidal waves in such an igneous ocean, and desire rather to seek for the cause with an unbiassed mind, and as proceeding from natural causes such as we are acquainted with. It seems to me that in the crystallization of rock-masses we have a power of the most enormous character, working, it is true, by atoms; and so does molecular force, and what more tremendous, more irresistible? Enclose water in a casket of iron; freeze it, and the casket bursts like a fragile china-cup. If in the crystallization of vast rocks, under the pressure of superincumbent strata, an expansion of their volume takes place, the superincumbent beds will be subjected to tensile strain, at first moderate, subsequently intense, and then a fracture or snap, or giving way. If the rock-masses contract in crystallizing, fracture from tensile strain is equally possible. A bar of iron, broken by tensile strain, snaps with the report of a cannon; so the snapping of the solid rock-mâsses below may produce sounds like thunder or the rumbling of waggons. The snapping of great masses of subterranean rock might give rise to great chasms, to uplifts of the edges, and large tracts of strata, while the vibration of the snap would ring through the earth for miles upon miles; its occurrence would be sudden, unpredicted, immediately dependent, perhaps, upon a sudden change of temperature, upon long-continued rain, or drought,—indeed, upon any unusual condition. Certainly, too, it is not a little singular that earthquakes are most frequent in the vicinity of the crystalline rocks of mighty mountains; in Chile along the line of the Andes, along the mountainous tracts of Wales, and the same in Scotland, along the Pyrenees, and most frequently of all along the most gigantic mountains in the world—the Himalaya. One can understand a rugged mountainous tract being uplifted, self-uplifting by expansion, by crystallization; but one cannot understand a mountain being permanently upheld on a gaseous explosion, or buoyed up by a generation of steam at high pressure. All such theories presuppose mighty caverns in the interior of the earth's crust, or the earth itself, for the generation of such steam or gases; and after that these have expended their energy, are we to suppose that the tract upraised reposes on nothingness? Is it not worth studying to find out *what* effects the crystallization of vast rock-masses are capable of producing?

NOTES RESPECTING THE ORIGIN OF THE WORLD.

By Thomas Harrison, of Melbourne.

The tyro in geology usually experiences no small difficulty in realizing the present theory of the world's formation. The various sedimentary rocks are of such vast thickness, that the question is very naturally put, as to where such an immense amount of detritus could possibly have been originated; and although not exactly so taught in elementary works, there are few students of geological science who do not come to regard granite as being not only the foundation of the globe, but also the grand storehouse whence, in the shape of water-worn and eroded fragments, has been obtained the whole mass of the purely aqueous strata.

With the above questions come yet others: Whether there is a possibility so hard a material could be so completely broken up as to form clay-slates, mud-stones, and others of almost impalpable grain and texture? Whether there is good ground for supposing lime, magnesia, alumina, and iron are found sufficiently plentiful in any species of granite to have given rise to the extensive deposits of such minerals found in particular formations? and also, how it is that various rocks, all proceeding from the parent granite, should differ from each other in their component parts so materially, merely as such rocks have been the product of different geologic ages?

The first of these questions is generally referred to almost an infinity of time, during which the erosive action has been going forward; whilst sorting of materials, chemical changes, and the influences of organisms, in the shape of plants and animals, are put forward as affording satisfactory explanations of the two following difficulties.

The case, however, even admitting the correctness of the preceding propositions, can hardly be regarded as clearly proven. The respective thicknesses of the three different formations—primary, secondary, and tertiary, are in the very inverse order of what might be expected in such a series, successively accumulated from the wearing away of an original indurate mass by a primeval ocean. Since, by the above theory, the primary rocks have only one source, the granite, whilst the secondary have at least two, the same granite and also the comparatively soft strata of the primary deposits, from whence these several materials might have been derived,—it requires but little discernment to see that, allowing an equality of time for the production of each, the latter ought to be immensely the greater of the two. The fact is, however, the directly opposite; whilst the tertiary, derivable from three distinct sources,—to say nothing of volcanic agency during this last period,—is far smaller in its development than either of the aqueous formations immediately preceding. Nor is it fair to demand a longer period for the accumulation of the older strata; since the earth being, in those ages, comparatively new and unsettled, it can scarcely be supposed that the times of quiescence allowing depositions to go forward would be more extended than in the latter geologic ages, during which the earth may be regarded as approaching a state of actual repose.

One might also reasonably expect, under the circumstances, to find the water-worn materials, of which the sedimentary rocks were formed, growing gradually smaller in all the latter deposits, since these last must necessarily have been subjected to by far the greater amount of wearing action from their frequent changes of position. Here, again, facts are decidedly against the theory of primitive granite being the origin of the earth's sedimentary crust,—conglomerates and gravels being rare in the secondary, and almost unknown in the slate rocks; whilst modern tertiary gravels, containing pebbles, and even angular fragments of quartz and granite, are common in every land wherein tertiary deposits are to be found at all.

Granite, again, is believed to have been produced under immense pressure,—a condition altogether irreconcilable with the idea that such granite was formed as a surface rock. The weight too of granite would appear to offer a most striking argument against its assumption of so high a position upon the gradual cooling of the earth's materials, some of which are known to be of very trifling density.

But even supposing the great framework of the globe to be of granite, still we cannot help agreeing with Mr. Jukes that the analogy drawn from the phenomena observed upon the cooling of lavas and other molten matter, would rather suggest the surface of recently solidified earth must necessarily be covered by vast heaps of ashes, scoriæ, and such light materials as naturally floated above the recently liquid mass below.

Admitting the above supposition as reasonably correct, we have at once an immense amount of material, likely to contain portions of very many of the substances, the bulk of which sank by their superior gravity towards the earth's centre; and besides, matter especially in a condition such as would admit of the mass being easily eroded and swept away by the storms and tempests, in all probability incidental to such an early period. The detritus of this material would go to form the lower strata of the globe, whilst the upper might owe their origin both to the subsequent erosion of the first strata deposited, and also to vast eruptions of volcanic matter from the interior of the yet unsettled earth. The admission of the latter, the volcanic agency, fully accounts for the great variety of minerals and metals found deposited in rocks during different ages, whilst the varying character of lavas ejected in the same localities, yet separated by long intervals of time, would in some measure show the reasonableness of the supposition that the interior of the globe is in reality the grand repository whence every mineral had its origin.*

Assuming the nebular theory to be correct, the following would appear to be the sequence of changes occurring during the earth's formation.

All matter existing originally in the form of a gaseous mass, the particles of which were kept separate by the contained caloric, on cooling to a certain point, the least easily volatizable parts would assume either a solid or a liquid form. Immediately on this taking place, the particles so forming, would of necessity rush together by the force of gravity, and must inevitably meet and form a solid or liquid nucleus to a surrounding nebulous atmosphere. The contained heat of the nebulous atmosphere still further decreasing, other solid or fluid matter would be formed, and would be deposited in the form of a stratum upon the solid or liquid portion first originated. In this way would be built up, as it were, a vast globe, whose materials would be arranged in layers or strata, the order or position of which would be the order in which they respectively solidified.†

During the formation of such a globe, it might sometimes happen that a stratum of a greater specific gravity would immediately succeed one of less. If the former chanced to remain a fluid, it is evident the two would be placed in a state of instable equilibrium, and that the, at first, lower stratum would, by the inevitable laws of gravity and hydrostatics, ultimately assume the higher position. This state of things may be realized by imagining iron or other light metal and mercury to be introduced, both in a state of vapour, into the same receiver. If the lighter metal were the first to assume the solid form, it would be naturally deposited upon the bottom of the containing vessel, but would rise to and float upon the surface of the mercury immediately on the latter's condensation.

Applying this theory to the formation of the globe, let us suppose the granite at a given period to have been already precipitated, the heat of the nebulous mass being diminished by a required amount; and upon this layer of granite to be subsequently thrown down a fluid of greater specific weight, such as we know to be liquefied lava, trap, and basalt. Although specifically lighter, the granite crust might for a long time remain in its original position, forming, as it were, the bottom of the superincumbent molten ocean. On such ocean of molten materials would float the scum and scoriæ previously alluded to. Of such scoriæ would be formed the various strata, by erosion and subsequent deposition. Portions of this scoriaceous mass being in immediate contact with the molten materials, might be metamorphosed into gneiss, without being first redeposited by water; whilst schists and slates may represent those strata deposited by water and afterwards metamorphosed by heat, through being brought into fresh positions, as a result of convulsive movements.

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* In New Zealand there is said to be miles and miles of fine steel-dust covering the seabeach to a considerable depth; this dust is supposed to be ejected by volcanic action.

† So far, most part of the above theory is identical with that of M. Ampere, noticed in the 'Edinburgh Philosophical Journal,' vol. xviii. p. 339. The author, however, begs to state that he never heard of M. Ampère's theory until long after his own had been elaborated.

This state of things, however, could scarce continue; as the molten ocean penetrated the granite, or as portions of such granite became loosened and detached, immense fragments would necessarily rise to the surface, causing earthquakes, elevation of mountain-chains, or absolute protrusion of granite peaks,—just as the detached masses were large enough to cause the phenomena, or as the solidified crust was of sufficient thickness to offer resistance to the immensely powerful elevating forces thus acting from beneath.

It will be remarked that the assumed position of the granite in this theory exactly tallies with the hypothesis which supposes the granite to have been produced under an almost inconceivable amount of pressure, whilst the elevating forces thus necessarily generated by hydraulic agency alone, are so vast as amply to account for the throwing up of any mountain-chain whatever. Nor must it be forgotten that the rising of such a semi-molten mass as the granite, by breaking of the partially consolidated crust, might bring within the influence of the central heat, rocks which, during the period of their aqueous deposition had been subjected to a very low temperature, thus accounting both for the deposition and the change by heat of the slaty strata.

It is not argued that the above suggestions, which the author puts forward with the greatest diffidence, offer an explanation for every observed phenomenon in the earth's structure. Universal theories, like universal medicines, are ever open to suspicion. In the formation of a world it is probable that every known force played its appointed part; neither is it assumed that continued risings of the granite mass are the causes of modern earthquakes or volcanos. Both of these may be the result of chemical and electrical action. The author simply gives what is, to him at least, a partially new theory, trusting there may be at least one proposition contained in it which, by promoting discussion, may lead geologists one step nearer the truth; while he is fully prepared to relinquish the hypothesis whenever future examination, or further discoveries, show it to be false.

ON CERTAIN CRETACEOUS BRACHIOPODA.

By E. Ray Lankester, Esq.

In the Plate accompanying this paper are figured three species of Terebratulæ, which the writer lately obtained from the Lower Greensand beds of the Isle of Wight. Two of them are interesting as being entirely new to these strata in Britain, whilst the third is a remarkable deformity of a rare species. In Fig. 1, 2, 4, a shell is drawn which appears to be identical with the *Terebratula Moutoniana* of D'Orbigny, a species not uncommon in France, associated with *T. sella* in the Upper Neocomian and Aptian beds of that author. It is somewhat oval in shape, depressed and elongated; surface entirely smooth. The perforate valve is rather more convex than the other, truncated by a foramen of moderate size; deltidium very short and small. Nine specimens of this species were obtained from the ferruginous Greensand beds, at Dunnose Point, near Shanklin. This shell, on external examination, is easily distinguished from *T. sella*, which it somewhat resembles, by the absence of any biplication on the frontal margin. Its internal structure proves it to belong to the section Waldheimia of King, which precludes all doubt as to its specific distinctions from *T. sella.* It is easily distinguished from *Waldheimia Celtica*, Morris, by its less elongated and gibbous outline. The specimen drawn in Fig. 5, 6, 7 is the only specimen of the kind which the writer has obtained. The valves are lenticular, beak much produced, foramen very large and circular, deltidium large. Mr. S. P. Woodward is inclined, with the writer, to regard this shell as *Terebratula depressa,* Lamarck (*T. nerviensis* of D'Archiac), a species which has not hitherto been found, excepting in the Upper (?) Greensand beds of Farringdon, and in the Tourtia of Belgium. Since, however, two species, *T. tamarindus* and *T. oblonga,* are already known as common to the strata of Shanklin and Farringdon, it is not surprising that *T. depressa* should have a similar vertical range. In Fig. 8, 9, a curious deformity of the *Terebratula Celtica* of Morris is drawn. This specimen was obtained from the same locality as the two former species. The beak is very much produced and incurved, whilst a deep furrow or groove runs along the median line of the perforate valve, and a corresponding elevation marks the smaller valve. *T. tamarindus,* "a rare British cretaceous fossil" (Dav.), was also obtained in considerable quantities,—Fig. 11.

The rarity of some species and the paucity of any great variety of the forms of Brachiopoda in the Lower Greensand strata of England as compared with the large number of species characterizing the Continental beds usually considered as their "homotaxis," is somewhat remarkable. There is no obvious reason why such forms as *T. diphyoides*, *T. hippopus* and others associated with a common British species, *T. sella*, in the Upper Neocomian or Urgonian beds

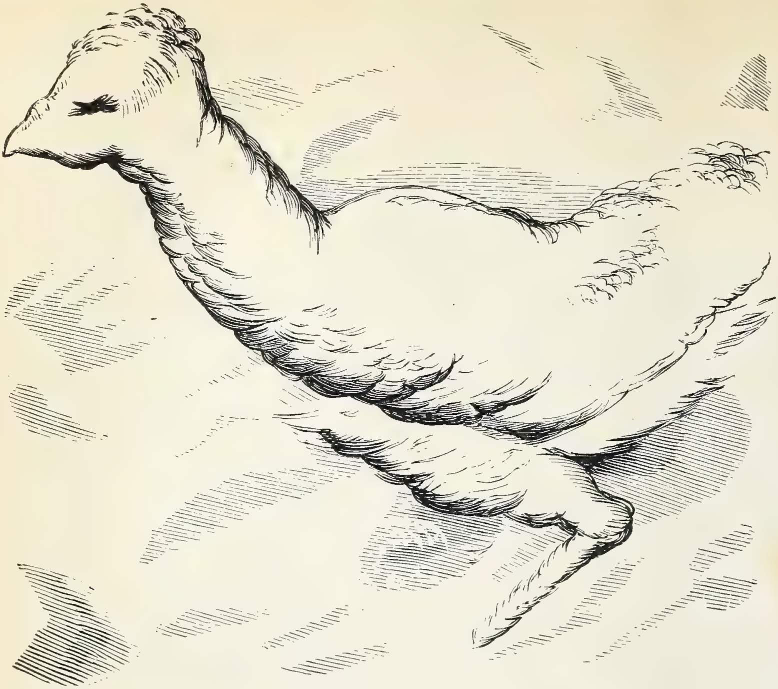


Fig. 1.

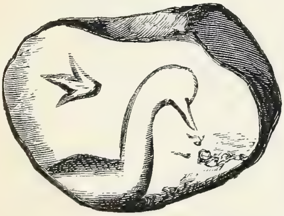


Fig. 2.

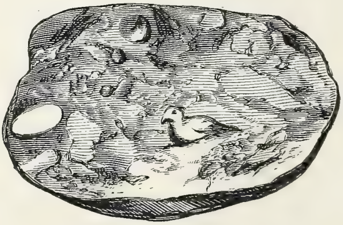
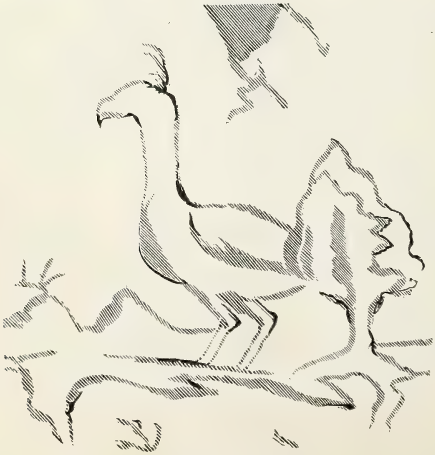


Fig. 3.

Fig. 4.



FOSSIL BIRDS.—Facsimiles from Mylius, Hermann, and Ritter.

of France, should not be met with in this country; and it is to be hoped that careful search will bring some of them to light to fill up the vacant spaces in our lists of species. The following are the species of Terebratulidæ, identified by M. D'Orbigny in France, and by Mr. T. Davidson in England, from Neocomian and Greensand strata.

Lower Neocomian.—*Terebratula tamarindus, T. pseudo-jurensis, T. prælonga, T. faba,** *T. Moreana, T. Carteroniana,*† *T. Collinaria,*† *T. Marcousana, T. semistriata, T. hippopus, Terebratella oblonga, T. reticulata, T. Neocomiensis, Terebratulina biauriculata, Terebrirostra Neocomiensis.*

Upper Neocomian or Urgonian.—*Terebratula hippopus, T. diphyoides, T. Moutoniana, T. sella.*

Aptian.—*Terebratula Moutoniana, T. sella, Terebratella Asteriana.*

Lower Greensand (England).—*Terebratula tamarindus, T. prælonga, T. Celtica, T. sella, Terebratella oblonga,* to which I now add *T. Moutoniana* and *T. depressa.*

FOSSIL BIRDS.

By the Editor.

The wonderful remains of the Archæopteryx, recently acquired for the British Museum, have naturally drawn attention to a much-neglected department of palæontology; and it will therefore not only be interesting, but useful also to the advance of science, to pass under review, at the present time, the state of our knowledge of the former existence of birds during past geological ages. The early authors, for the most part, speak not of fossil bird-remains properly so called, but in reality of mere incrustations by "petrifying springs," of the fanciful tracery of dendritic markings, or the imagined resemblances of oddly-formed stones. Thus Albertus Magnus, in his book 'De Mineralibus,' printed in 1495, describes a fossil nest, with eggs, on the branch of a tree. This might or might not be a true *fossil*, but our recent discoveries of fossil birds and reptiles' eggs, and the knowledge we have now of delicate objects truly fossilized, such as insects, fruits, flowers, and feathers, renders it possible that some of the old records of such may have had a foundation of truth, and gives a probability that some at least may be brought within the capacity of belief as actual facts.

With this view, we shall quote from the old authors all the passages known to us, commenting on them as occasion may require; and in thus working up the bibliography of fossil ornithology and arranging the whole of our knowledge of the subject, as far as we have the power to do so, we shall be able to separate facts from fictions, and give a solid basis for further investigations in the future study of ornithological palæontology.

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* The shell to which M. D'Orbigny has erroneously applied Sowerby's name of *T. faba*, is identical with the *T. Celtica* of Morris. The *T. faba* of Sowerby is merely a variety of *T. biplicata* confined to Upper Greensand strata.

† *T. Carteroniana* and *T. Collinaria* appear to have been regarded in this country as forms of *T. sella*.

The first record of any allusion to petrified bird-remains is by ALBERTUS MAGNUS, in 1495. His remarks evidently refer to those incrustations by calcareous springs which we should never now dream of associating with true fossils. Still, it is necessary for our purpose to record these, that the true may be separated from the doubtful; while moreover these instances, if at all reliable, will serve the good purpose of illustrating the conditions under which true fossil ornithic relics may have been produced in the former geological ages of our earth. Such records are not to be cast aside as useless, for more reasons even than these. The following is the account given by this naturalist Bishop of Ratisbon in his 'Liber de Mineralibus,' published at Venice:—

"In our time there was discovered in the Danish Sea, near the city of Lubeck, a big branch of a tree, whereon a nest of birds was found, and small woodpeckers in the nest, all converted into stone of a reddish colour; the which cannot be otherwise explained than that the tree, at the time when the nest was in it, was rooted up by a storm, and the birds, drowned in the water, were afterwards, by the effects of local circumstances, entirely converted into stone. There is also in Gothia a spring, respecting which tradition states that everything that is immersed in its water is converted into stone. The Emperor Frederick, wishing to ascertain the truth of this, ordered some sealed parchments to be put therein; these having been kept there for a few days, the half of the skin, and the seals that is, the part submerged in the well, was changed into stone, the other part still remaining as it was. It is also positively stated by trustworthy people that the water-drops, which are dashed here and there by the force of the spring, are converted into as many stones as there are drops; the water itself however is not changed into stone, but continues to flow. We witness also the formation of crystals in the most elevated mountains perpetually covered with snow, which phenomenon cannot be ascribed to any other cause than to the virtue of the minerals which exist in those places. From all which we see that it is very difficult to determine the place of generation of stones, the more so as they are formed not from a single but from many elements, and not under any special but under every climate; and what seems more marvellous, they are generated as well in the bodies of animals as in the clouds, and their formation in all of these places renders it scarcely possible to reduce them to the same common matter. But as we cannot doubt that for a body of a compound nature there must be a generative cause, so it must be thence inferred that every kind has its peculiar place of generation, outside of which it decays and corrupts."

"Aliquando namque tempore nostro in mari Danico juxta civitatem Lubi-

ensem inventus est ramus magnus arboris, in quo erat nidus avium: et aves pice in nido: et converse in lapides erant parvi in nido param declinantes ad rubedinem quod aliter esse non potuit nisi quod procellis vel undis evulsa arbor tempore quo in ea fuit nidus et aves in aquam ceciderunt: et postea, per virtutem loci in quo jacebat, in lapidem universa conversa sunt. Est autem fons in Gothia: de quo verissime traditur, quod omnia que merguntur in ipsum in lapidem convertit: in tantum, quod ad eum misit Imperator Fredericus cirotecam sigillatam ut probaret veritatem, que cum per aliquot dies medietas corii et medietas sigilli mersa erat in fonte: medietas corii et medietas sigilli conversa sunt in lapidem, altera medietate corio manente. Refertur et veraciter a fidedignis quod gutte que ex impetu casus ejusdem fontis sparguntur, super ripam fontis convertuntur in lapidem guttarum quantitatem habentes: cum tamen aqua que sic fluit non convertatur in lapidem: sed fluit continue. Videmus etiam oculis generari cristallos in montibus altissimis: qui sunt perpetuarum nivium: quod iterum esse non potest nisi per virtutem minerallium que est in locis illis. Ex quibus omnibus videtur non posse certum aliquid tradi de loco generationis lapidum: cum nec in uno tamen elemento: sed in pluribus nec etiam in uno tamen climate sed in omnibus. Et quod his mirabilius videtur, in corporibus animalium generantur et in nubibus, que omnia loca difficile videtur, valde ad unam materiam in communi reducere: cum tamen hoc sit necessarium, eo quod non dubitamus ejusdem corporis mixti secundum genus etiam unum secundum genus esse generativum. Oportet enim quod omnium generatorum sit locus aliquis sue generationis, extra quem corrumpuntur et destruuntur."[*]

The next earliest author is GEORGIUS AGRICOLA (1546), in whose work, 'De Natura Fossilium,' lib. x. p. 370,[†] he says:—

"Like the wood of the blackthorn, but not the same, is a fissile stone at the base of the mountain Melibocus, or, as it is now called, Hercynium, near Eisleben, Mannesfeld, Hostedt; it is black, bituminous, and full of brass, and when extracted from the pits it is first spread on the field, and being thus accumulated forms a heap. Afterwards the lower part of the heap is surrounded with twigs, wherein likewise some of the same stones are thrown, and then the twigs are set on fire; the stones which are at the top of the twigs take fire, and communicate it to the others close by, and these kindle the rest. This faculty of being easily ignited is a common characteristic of bitumen and sulphur. However, they show but small veins of pure and black bitumen, and while burning they emit a smell like that yielded by bituminous coals when blazing. When, at the time they are burning, some rain falls on them, they burn brisker and soften quicker. Likewise, when the smoke which rises upwards is cast by the wind on to standing water, there is quickly a sort of bituminous matter to be perceived on the surface, all of which sufficiently proves that these stones are bituminous. The stones

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[*] ALBERTUS MAGNUS, 'De Mineralibus,' lib. i. p. 3. tract. f. cap. vii., edit. 1495.

[†] The works of Agricola are—'De Ortu et Causis Subterraneorum,' lib. v. 'De Natura eorum quæ effluunt ex Terra,' lib. viii. 'De Natura Fossilium,' lib. x. 'De Veteribus et Novis Metallis,' lib. ii. 'Bermannus, sive de Re Metallica Dialogus.' 'Interpretatio Germanica Vocum Rei Metallicæ, addito Indice fœcundissimo.'—Basileæ, edit. 1546.

of this kind met with in the forest of Hercynium are sometimes covered with a crust of sparkling gold-coloured pyrites. They represent also now and then figures of animals, as for instance, of kinds of fishes: Flat-fish, Pikes, Perches; of the bird-kind: cocks, hens; sometimes also salamanders. Nay, even an image of a bearded Roman pontiff, wearing on his head the three-storied crown (tiara), has been discovered, and which has been seen by many. Besides this, the image of the Holy Virgin also, holding the baby in her arms. There appear also sometimes in *Chattis* species of fish of this sort of incrustations.

"Lastly, at Anneberg, on digging the Thomashirn pit, a bituminous ore has been discovered, which, thrown on to live coals, burned and yielded a smell like wild garlic, and finally was reduced to ashes, containing but very little silver."

The following is a transcript of the original text:—

> "Spino similis, si non idem, est lapis fissilis ad radices Meliboci montis, sive, ut nunc vocant, ad Hercynium effossus Eislebæ, Mannesfeldi, Hostedæ: is niger, bituminosus, ærosus, primum ex puteis extractus in aream effunditur, atque ita ex ista coacervatione oritur tumulus. Deinde inferior tumuli pars circundatur sarmentis, in quæ similiter injiciuntur id genus lapides; tum sarmentis admoto igni accensis, ignem etiam concipiunt lapides super ea conjecti. Hi proximis quibusque impertiunt ignem: atque omnino omnes qui jam ardent, eis proxime adjunctis, ut autem facile ignem concipere signum sit bitumini commune cum sulfure: tamen parvæ puri et nigri bituminis venæ interdum ejusmodi lapides distinguunt: et, cum ardent, talem odorem emittunt qualem carbones bituminosi cum flagrant emittere solent. Præterea si quando in ardentes mediocris pluvia decidit, magis ardent, et citius mollescunt: quinetiam ubi ventus fumum qui sursum fertur, in proximam aquam stantem dejecerit, mox in ea innatare aliquid instar liquidi bituminis licet cernere, quod vel nigrum est, vel fuscum, vel purpureum: quæ omnia satis declarant eos lapides esse bituminosos. Atque id genus lapidum, ad Hercynium nemus inventum, crustæ interdum scintillis pyritæ aurei coloris adhærentibus. Et discurrentibus exprimunt varias animantium species, ut in genere piscium passeres marinos, lucios, percas: in avium gallos gallinaceos, nonnunque salamandras. Imo pontificis Romani barbati, et triplicem coronam in capite habentis, effigies reperta est, quam multi viderunt. Præterea beatæ Virginis puerum in manibus gestantis. Reperiuntur etiam in Chattis interdum species piscium in istius generis crustis. Nuper etiam Annebergi, cum ageretur Thomashirni cuniculus, effossa est cadmia bituminosa, quæ in prunas conjecta ardet, ac olet allium sylvestre et tandem in cinere abit, parve vero argenti in se continet."

The work which, so far as we know, follows in sequence, is the 'De Thermis Andreæ Baccii, Elpidiani, Civis Romani, apud Sextum Quintum Pontificem Maximum Medici, Libri Septem, Opus Locupletissimum, non solum Medicis necessarium, verum etiam studiosis variarum rerum naturæ perutile, etc., Venetiis, 1588,' p. 274; in which, discoursing "*on the nature of the salt growing in* Transylvania," he says, "Of the nature of rock-salt and bay-salt, which seem to grow and increase from moisture and springs, we have already sufficient information conveyed to us by Vernherus; we may, nevertheless, add here some facts deserving of notice which we have retained in our recollection. Amongst others, whilst the salt destroys common iron, there have been iron-implements and wood discovered after having been left for years in it. In a certain place there was a hen found which, together with her eggs, had been buried in salt and was thus preserved, and is still exhibited uncorrupted."

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* Also in edit. Patavii, 1711, lib. v. cap. iv. p. 157 (word for word).

The Latin text is given below:—

"*Salis Natura quæ vegetatur et crescit in* TRANSYLVANIA.—Salis vero scissilis ac montani naturam ex humore aut succo id genus aliquo vegetari, ac crescere, satis quidem fidem facit idem Vernherus; nec minus ex nostris præclari aliqui testes, qui multa mihi hac in parte memorata digna retulere, quæ referam. Inter alia vulgare fere dum sal exciditur, relicta elapsis annis instrumenta ferrea, ac ligna in eis reperiri. Quodam loco gallina cum ipsis ovis incubans reperta est, quæ eo obducta sale servata est, ac incorrupta etiam nunc ostenditur. Jam magna ex eis fodinis carbonum vis erui solet cum sale et vetustissimæ roboris trabes. Sal gemmeus, qui lucidior est omni sale, cum in fundo reperitur, indicium fodientibus est inferius nullum esse salem, aut impuram terram, ceu matricem reperiri. Abundat et vicina Polonia hujus generis nativo sale saxeo in syncero tamen, ac magis solido."

The quotation which follows is from the work of JOH. DAN. MAJORIS, Phil. et Med. D., 'Dissertatio Epistolica de Cancris et Serpentibus Petrefactis, ad Don. D. Philippum Jacobum Sachs à Lewenheimb. Medicum in Rep. Patria Vratislaviensi, cui accessit Responsoria Dissertatio Historico-Medica ejusdem Philippi Jacobi Sachs à Lewenheimb. Phil. et Med. D. et Collegii Naturæ Curiosorum Collegæ de Miranda Lapidium Natura,' p. 38.—Jenæ, 1664:—

"In the meantime we are certain that not only crabs (river- and sea-crabs), but also serpents, lizards, sea-urchins, star-fishes, scallops, cockles, oysters, shell-fish, clams, limpets, tellens and turbines, and vertebræ and spines of fishes, as well as *beaks of birds* and parts of other animals, as, for instance, teeth, nails, vertebræ, skulls, etc., through natural as well as artificial causes, are often encountered in the depths of the mountains and in the most hidden recesses of the earth, where neither man nor any other animal could ever penetrate; nay, they are sometimes discovered even in the very middle of marbles, that show not the slightest fissure, their bodies, either previously petrified or in their natural state, having been, so to say, buried in the abyss of the earth, at the occurrence of the Deluge or by some other cause, and which remaining there have acquired the hardness of stone, as might easily occur through the infiltration of saline springs penetrating through every portion of the earth. We observe also on ancient walls nitrous water oozing through and coagulating into white icicles of a conical form."

The original runs—

"Credamus interim non cancros solum, sive marinos, sive fluviatiles, sed angues etiam, lacertos, echinos, stellas pisces, pectines, cochleas, ostreas, conchas, chamas, mitulos, tellinas, turbines, pisciumque vertebras aut spinas, necnon *rostra avium* aut aliorum animalium partes, dentes videl. ungulas, vertebras, crania, et alia, tam a natura quam arte petita, in intimis sæpe montium visceribus, aliisque profundis terrarum latebris, quo nulla unquam gens, nullum unquam animal aliud facile penetrare posse videtur, immo in mediis interdum marmorum, in nullas rimas hiantium, corporibus, sive petrefacta jam, sive pristinam naturam utcumque servantia, eatenus reperta esse, quatenus talia, ut verbo dixerim, voragine terræ fuerint obruta, sive occasione Diluvii, sive casu alio; ibidemque per plurimos annos subsisterint, donec destructa sensim obnoxia etiam reddita Rigori Lapidifico, qui facile tandem supervenire ipsis potuit ob transsudantes passim Salinos, per Terram Succos, haud aliter, atque in muris antiquioribus Aquam nitrosam transudare, ipsamque in Stiria albas et conos coagulari conspicimus," etc.

Joh. Dan. Majoris, Phil. et Med. D., 'Dissertatio Epistolica de Cancris et Serpentibus Petrefactis, ad Don. D. Philippum Jacobum Sachs à Lewenheimb. Medicum in Rep. Patria Vratislaviensi, cui accessit Responsoria Dissertatio Historico-Medica ejusdem Philippi Jacobi Sachs à Lewenheimb. Phil. et Med. D. et Collegii Naturæ Curiosorum Collegæ de Miranda Lapidium Natura,' p. 38.—Jenæ, 1664.

Joh. Weilhard Valvasor, in his 'Ehre des Herzogthums Crain' (Lanbach, 1689), says, "Near Landspreis, on the mountain, I discovered in a ditch many sea-shells, which had acquired a stony hardness, or rather which were converted into stone; also a *bird's nest* together with a small bird sitting on eggs; which all together was transformed into hard stone by the lapidiferous spirit."

We extract the original passage from Theil 1 of this work, p. 478.

"Bey Landspreis, über dem Berge, bin ich in einem Graben auch vieler Meer-Muscheln ansichtig geworden, die eine steinerne Härtigkeit gewonnen, oder vielmehr die Stein-Art selbst angenommen; ingleichen eines Vogel-Nestes, mit einem kleinem auf den Eyern sitzenden Vogel; welches alles miteinander der Stein-machende *Spiritus* zum harten Stein gemacht."

Like all other books of its age, Peter Wolfart's 'Vale Hanoviæ et Salve Cassellæ' (1707) has a very long title,* and more of a dilettante than a philosophic aspect. Medicinæ Doctor Wolfart has, however, something to say, and we will therefore let him say it in his own words (p. 12, etc.).

"§ IV. In order to enable every and any one the better to understand our *figures*, and to avoid confusion of them, we think it advisable, for the interest of the work, not to notice obscure or futile opinions about the origin of the specimens,—abundant as such opinions are, according to the fertility of the genius of every writer,—

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* 'Vale Hanoviæ et Salve Cassellæ dictum. Cujus Occasione Inventa quædam Hanoica utrisque Dilectissimis suis Popularibus Communicare, se suaque Studia de Meliori Commendare, atque prioribus benevolam sui memoriam relinquere voluit. Petrus Wolfart, Med. Doct., in Illustri Schola Patria Anatomiæ hactenus et Philosophiæ Experimentalis Professor, nec non utriusque Hanoviæ Physicus Ordinarius, nunc vero Physicus Aulicus Hasso-Castellanus, cum ad Stationem suam novam capessendam, Abitionem paratet. Anno Christi, 1707, die 18 Aprilis, Francfort ad Mœnum.'

and to separate the whole into two distinct classes; ascribing to one those which seem to be mere playthings of Nature, and to the other those due to the universal deluge, by which, according to what we learn from the sacred Scriptures (Gen. vii. 19), the whole earth was drowned and the highest mountains covered with water.

"§ V. In the first class we will arrange all those fossil bodies which represent various superficial images,—figures of ants, beetles, peacocks, fishes and other animals, and which, it seems, had been already frequently observed in the time of Pliny, who refers to them in his H. N. lib. 37. Athanase Kirchner seems to have been the first to observe them in marble, jasper, and agate-stone. Very interesting is what Pliny says (l. c.) about an agate belonging to king Pyrrhus, on which Nature has sculptured the figure of Apollo with his cithara, attended by the nine Muses, and on which, by a certain tracery of stains, the instruments of all the Muses were reproduced. See 'Disputatio M. Jo. Jacobi Lungershausen,' held at Jena, about the figured imitations of nature, showing many beautiful phenomena of agates.

"§ VI. Those marbles, which are very elegantly coloured, represent to our fancy various figures, as may be seen in many very curious specimens; they are, therefore, largely dug in our neighbouring principality of Idstein, where they adorn sacred as well as profane buildings, from the pavement to the roof. Not less interesting, and not yielding in interest to the above, whether we look at the most elegant pictures they produce, or whether we consider them as a plentiful supply of coloured marble, are the specimens which were lately communicated to us by a friend from the principality of Diz, and which we may recommend as particularly deserving the notice of our readers, the first three, fig. 1, 2, and 3, drawn correctly from the originals. The fig. 1 represents an entire human head, together with all other parts of the body, not inelegantly drawn. The fig. 2 represents a head of an Owl (see Pl. XXII. Fig. 1, *nobis*); and the fig. 3 a view of a country, which is but a mere play (artifice) of nature. With regard to the latter it may perhaps not be unsuitable to compare what D. D. Behrens in his 'Hercynia Curiosa,' p. 134, titl. xiii. says, about the quarry called the 'map-stone.' It is as follows:—'This stone is found in the quarries of the villages Petersdorff and Rudigers- or Riddigers- Dorff belonging to the Count Stollberg's estates at Hohestein or Neustadt, and the name of 'map-stone' was given to it because the veins of this stone bear in the most part the appearance of rivers as traced on maps.'"

The original runs thus:—

"§ IV. Quo vero eo melius hæc nostra figurata ab omnibus ac singulis intelligi queant et ut omnis eo facilius inter illa evitetur confusio; operæ prætium facturos nos putamus, si relictis aliis spinosis et futilibus circa illorum productionem oberrantibus opinionibus, cum hic quilibet suo videatur abundare ingenio, ea dispescamus in duplicem classem, alia adscribendo mero accidentali NATURÆ LUSUI, alia e contra a DILUVIO illo UNIVERSALI,

quo totam terram obrutam omnesque ejus excelsos montes aquis opertos fuisse, ex paginis sacris edocemur, Gen. vii. v. xix., derivando.

"§ V. Priori classi assignamus omnia ac singula illa corpora fossilia, quæ varias figuras, ut formicæ, scarabei, pavonis, piscium aliorumque animalium superficietenus tantum nobis exhibent, quod quidem frequentissime in lapidibus observari suo jam tempore docuit Plinius, H. N. l. 37. Præprimis huic negotio parere videntur Athanasio Kirchero Marmor, Jaspis et Achates. Memorabile sane est quod de Achate refert Plinius, l. c., quod videlicet Pyrrhoni Regi fuerit Achates, cui natura insculpserit Apollinem cum Cythara stipantibus novem Musis, certo Macularum ducta ita depictis ut simul instrumentum cujusvis Musæ emergeret. Vide Disput. M. Jo. Jacobi Lungershausen Jenæ habita de Imitamentis naturæ circa figuras, plura eaque egregia Achatis phænomena exhibens.

"§ VI. Marmora quoque elegantissime esse colorata variasque Phantasiæ nostræ obtrudere figuras, videre licet in variis speciminibus quæ passim ad curiosos transmittentur, et adeo copiose quidem in vicino nobis Principatu Idsteinensi eruuntur, ut illic ædes sacræ et profanæ iisdem a pavimento ad verticem usque splendescant. Minime vero his cedunt, sive frequenter in illis spectemus occurrentem elegantissimam picturam, sive uberrimum varie coloratum marmorum proventum, illa specimina quæ nuper nobis a singulari quodam amico ex Principatu Dizensi communicate sunt, et ex quibus Lectoris admiratione præprimis digna indicamus tria illa que fig. 1, 2, et 3, graphice et ad vivum delineata exhibent. Ex quibus fig. 1, integrum caput humanum cum aliis corporis humani partibus haud ineleganter repræsentat, fig. 2, caput Ululæ, et fig. 3, Tabulas Regionum miro sane Naturæ artificio sistit. Cum tertio non incongrue fortassis conferendum quod D. D. Behrens nobis describit in Hercynia sua curiosa, p. 134, tit. xiii., 'Von dem Steinbruch der Land-Karten-Stein genant,' hunc in modum: 'Dieser Steinbruch ist nahe bei denen uns benachbarten in den Hoch-Gräfflichen Stollbergischen Amt Hohestein oder Neustadt gelegenen Dörfern Petersdorff und Rudiges- oder Riddiges-Dorff genant anzutreffen, und hat den Namen daher bekommen, weilen die Adern dieses Steines in grossen Stücken, wie die Flüsse in denen Land-Karten ein Ansehen haben.'"

We really seem to have the record of a true fossil, although the statement is mixed up with the wonderful tales of Agricola and Albinus, in the 'Piscium et Querelæ et Vindiciæ, expositæ a Johanne Jacopo Scheuchzero, Med. D. Acad. Leopoldin. et Soc. Reg. Anglicæ ac Prussicæ Membro,' pp. 14, 15.—Tiguri, 1708. See figure in plate ii. (copied in Pl. XXII. Fig. 2, *nobis*).

We had rather, however, the Doctor should speak for himself.

"Behold also, a tail of a bird, or a remige-feather, in the fissile stone of Oeningen, the only specimen hitherto known of the remains of the winged kingdom except the gallinaceous bird quoted by Agricola in his Foss. 4. x. p. 371, in concurrence with the image of a bearded Roman Pontiff, wearing on his head the triple crown; the existence of which latter is however questionable, the more so, as in the public Records of Eisleben no mention is made about it, according to Cl. Don. Gothofr. Mylii Memorab. Saxon. Subterr. p. 5; yet it must have been so, as the stone not long after the Reformation, about the year 1539, was presented, first to Luther, and then to Francis I., King of

France. Moreover, according to Albinus, p. 105, it is said, that the image of the Pontiff was adorned with a triple crown, and the pontifical robes were of tissue made of gold-like and purple thread, and the human eyes, ears, and nostrils, distinctly shown; the figure of the Pontiff sitting in a splendid chair, raising his right hand, on which even a jewel (*St. Peter's ring*) could be observed.*

The original text is:—

> "Ecce enim CAUDÆ *avis* vel REMIGEM *pennam* in Lapide fissili Oningensi conspicuam, unicum, quod hactenus fit cognitum ex Volucrium Regno superstes monumentum. Excipite *Gallum Gallinaceum*, cujus meminit Agric. 4, x. *Foss.* p. 371, juxta Pontificiis Romani *barbati et triplicem coronam in capite habentes effigiem*, de cujus tamen existentia merito dubitatur, quandoquidem in Actis Publici Eislebiensibus ne minima quidem fiat mentio, teste Cl. Dn. *Gothofr., Mylio Memorab. Saxon. Subterran.* p. 5, fieri autem debuisset Lapidis et non longe post Reformationem, anno nimirum 1539 eruti, dono dati primum *Luthero* postea Francisco I. Galliarum Regi; præsertim si, quod *Albinis* scribit p. 105, *Pontificis effigies* ad fuit *ornata* triplici corona *et veste* Pontificiali, aureis quasi filis et purpura contexta, *os, oculos, et nares hominis, referens, in sella splendida sedens, denique dextram manum sublevans, inquam tanquam gemmam contemplans intuebatur.*"

It is difficult to know what Mylius (1709) means in the following passage:—

"I am bound to mention also that in the same quarry (Illmenau), a few years ago, a model has been discovered, which presented a HEN very distinctly reproduced, and which is the more remarkable as even the intestines of the hen were imprinted."

He follows these remarks with others about fish-remains, which are more likely to have been true fossils:—

> "Ich muss auch ferner mitberühren, dass eben in diesem Wercke, vor wenigen Jahren noch, eine Niere, in welcher eine Henne ganz deutlich abgebildet war, gefunden worden, so um desswillen *remarquabel*, dass dieses Bergwerck diese Henne in seinen innersten Eingeweide exprimiret."†

Buttner, in his 'Rudera Diluvii Testes' (1710), says that "near Lubeck, there was once discovered a petrified branch of a tree, together with a bird's nest. A petrified twig, very nicely formed, is also shown in the Museum of Arts at Florence."

Further on is another passage:—"To this happy circumstance (*i. e.* a communication from the Pastor Webel) I owe also a confirmed assurance respecting a bird's nest discovered *there* (*i. e.* near Kindelbrück, in Thuringia), together with four or five white eggs (like quails' eggs), and a stone four yards round,‡ which was very firm, and a *figure* of which was shown to me by another friend, as represented on plate xxi. fig. vi." (see Pl. XXII. Fig. 3, *nobis*).

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* In the British Museum copy the plate containing the figure of the bird from Œningen is wanting.

† Mylius, 'Memorabilium Saxoniæ Subterraneæ,' Leipzig, 1709, p. 47.

‡ Literally, "4 *Ellen starck*."

We give the text of these passages :—

"Bei Lubeck wurde einst ein versteinter Ast mit einem Vogel-Nest gefunden. Ein versteinter Zweig, gar artig proportionirt, wird in der Kunstkammer zu Florenz gewiesen," p. 187.

"Eben bei diesem glücklichen Zuspruch bekomme nochmahlige Versicherung, wegen eines daselbst gefundenen Vogel-Nests, darinnen 4 oder 5 weisse Eyer, als Wachtel-Eyer, und ein Stein der 4 Ellen starck und sehr feste gewesen gelegen, welches mir von einem andern Freunde vorgebildet worden als Tab. xxi. weiset." [M. D. S. Buttner's 'Rudera Diluvii Testes,' p. 218, pl. xxi. fig. 6.—Leipzig, 1710.]

"I cannot present now," says M. Hermann, in his 'Maslographia'* (1711), "all the figures which I possess on my polished pyramids, squares, and other big stones, but I will, nevertheless, give a few of them, plate xiii., from R. 12 to 17, as they are in a polished state." It is unfortunate for us M. Hermann could not do all he evidently wished, but for our purpose he has done quite enough, and we copy his fig. 17 (in our Pl. XXII. Fig. 3), as it has been referred to amongst the statements of bird-remains.

Hermann also gives in tab. xi. fig. 99 another figure, which we also copy, describing it in his text as "a white stone with the neck of a goose" (see our Plate XXII. Fig. 3).

"Fig. 99. Lapis albus cum collo anserino. Ganss-Hals."

(*To be continued.*)

CORRESPONDENCE.

Homo sapiens versus *Pithecus indocilis.*

Sir,—Page 392 of your periodical for October, contains an allusion to the Andaman Islanders. The subjoined extracts from the 'Friend of India,'† of the 6th August last, may perhaps tend to show that their degraded condition is more to be attributed to the circumstances attending their mode of existence (*toto orbe divisos*) than to any natural deficiency of intellect in them; that their apparent low condition, relatively to the rest of mankind, is owing to deficiencies which are more acquired from the circumstances which have surrounded them hitherto than inherent in themselves.
W. T. N.

Extracts.—"Never, we venture to say, has the Government of India published such remarkable documents as a Report by Lieutenant-Colonel Tytler, with a narrative, by the Rev. Henry Corbyn, of attempts to civilize the pigmies who inhabit the Andaman Islands." . . . "Mr. Corbyn declares he has unquestionable proof that the Andamanese, who are 'most imitative and possessed of extraordinary memory and quick intelligence, may soon acquire our language;' and he speaks of 'the submissive and orderly conduct, good temper, and the pleasure evinced by the twenty-eight inhabitants of the Home.'" . . . "We would commend Mr. Corbyn's narrative to the study of those who, like Sir W. Denison, enter the lists in a mild fashion against Mr. Darwin and Professor Huxley, in defence of the dignity of the race and its generic difference from the gorilla. If Mr. Corbyn's record is to be trusted, the fact that the most degraded specimens of humanity yet discovered can be taught in a few weeks to show extraordinary memory 'and quick intelligence,' to distinguish the letters of our alphabet and read words of two syllables, will not be overlooked by those who hold the old-fashioned belief that God made man in His own image."

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* The title of this work is,—"Maslographia, oder Beschreibung des Schlesichen Massel, im Oelfs-Bernstädtischen Fürstenthum mit seinen Schauwürdigkeiten. Von Leonhard David Hermann. Brieg. 1711."

† One of the first newspapers in the East.

Southampton, 3rd October.

Mr. Guppy's Article on Trinidad Rocks.

My dear Sir,—I am very sorry to see by your last number that Mr. Guppy has most unaccountably misapprehended the tenor and purpose of my former letter to you. I was perfectly aware that Mr. Guppy was not the authority for the correlation of the beds in question with the Neocomian of Europe; nor do I for one moment raise any objection to the connection of the two series of rocks. I merely objected to the use of the term "age;" and without dissenting in one particular from Mr. Guppy's statements, took the opportunity of referring to Professor Huxley's views on "homotaxis." Your correspondent himself states that he has held views similar to those in question; and I am, therefore, surprised that he should have troubled himself to enter into an explanation on other matters, which was alike unnecessary and uncalled for.

Let me assure Mr. Guppy that I concur in all that he has written on this matter, saving the one word "age;" and I am sorry that he should have thought it worth while to correct an error which had no existence but in his own imagination. Yours truly,

E. R. Lankester.

8, *Savile Row, W.*

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Liverpool Geological Society.—The abstracts of the proceedings of this useful society, for the sessions of 1861–2 and 1862–3, have just been printed; they commence with the Report of the Excursion to Holywell on the 11th July, 1861.

The mountain limestone of that neighbourhood contains many species of the ordinary fossils in profusion,—*Productus giganteus*, *P. semireticulatus*, *Lithostrotion basaltiforme*, and *Syringopora geniculata* being the most common. The formation is there divided into the following subdivisions:—1, numerous beds of Chert; 2, Shale and Limestone, with concretions of chert; 3, Black Limestone; 4, White Limestone. The position of the chert nodules in No. 2 is similar to that of the flints in the Chalk, but their form is different, being round flat concretions, thick in the centre, and gradually thinning towards the circumference.

Next follows the Report of the Excursion to Coalbrookdale, on July 31st.

The excursion occupied two days, which were devoted to examining the Silurian strata. The low land to the west of Coalbrookdale, towards Buildwas, is Wenlock Shale; the lofty ridge, including Benthall Edge and Lincoln Hill, is Wenlock Limestone, with the millstone-grit and coal-measures reposing thereon. The following fossils were collected upon the occasion, from the Wenlock Limestone:—*Heliolites Murchisonii, H. megastoma, Propora tubulata, Favosites Forbesii, F. cristata, F. fibrosa, Lebecheia conferta, Halysites catenularia, Syringopora bifurcata, S. fascicularis, Thecia Swindernana, Cyathophyllum articulatum, Omphyma Murchisonii, Aveolites Grayii, Cystiphyllum sp., Calymena Blumenbachii, Athyris tumida, Rhynchonella sphærica, R. nucula, R. borealis, Atrypa marginalis, A. reticularis, Strophomena depressa, Euomphalus rugosus, E. discors, E. sculptus, E. funatus, E. carinatus;* from the Wenlock Shale; *Encrinital Stems, Calymena tuberculosa, Lingula sp., Orthis hybrida, O. biloba, O. elegantula, Rhynchonella sp., Leptena transversalis, Acroculia?* Crustacea are rare at Coalbrookdale, when compared with the same formation at Dudley.

Amongst the papers printed, are "On the Inferior Oolite," by the Rev. S. H. Cooke, M.A. The Inferior Oolite, as developed among the Cotteswolds, especially near Cheltenham, consists of four chief divisions,—1. Ammonite Sands, about forty feet thick, by some considered to belong to the Upper Lias, but probably a transition bed between that and the Inferior Oolite. *Rhynchonella cynocephala,* and many Ammonites are peculiar to it. The best sections are to be seen at Frocester and the Haresfield Hills. 2. Pea-grit or Pisolite, about forty feet in thickness, confined to the immediate neighbourhood of Cheltenham. 3. Freestone and Oolitic Marl series, about one hundred and ninety feet thick at Leckhampton Hill; the freestone is much quarried for building, but generally unfossiliferous. The Oolite marl-bed, about seven feet thick, contains many fossils. Near Stroud it contains a thin coral reef, with Nerinæa. 4. Ragstone, about thirty-eight feet in thickness; a hard gritty rock, with many fossils. It is subdivided into Gryphite-grit, Trigonia-grit, and Pholadomya-grit. The first of these exclusively affords *Gryphæa Buckmannii,* which is also found in the Swiss Jura and Swabia; Chemnitzia, Pholadomya, and Gresslya abound in this division. It maintains a nearly constant thickness over the whole district, while all the inferior divisions, including the Upper Lias, thin out and gradually disappear towards the east and south-east. Thus, at Stonesfield the Ragstone is thirty feet thick, while all intermediate strata between it and the Upper Lias are omitted; the latter is six feet, resting on the Marlstone twenty-five feet. The Inferior Oolite is also developed near Dundry, where the chief fossiliferous bed probably corresponds in place with the Cheltenham Pisolite; also in Dorsetshire, near Bridport, where it forms the coast-section, but is much disturbed by faults. Its fauna in these more southern localities differs much from the Cotteswoldian, the Bristol coal-field having formed a complete barrier between. It is also developed on the Yorkshire coast, near Scarborough.

"On the Stonesfield Slate, and its associated Strata." By Mr. W. S. Horton. The term Stonesfield Slate is applied to a bed which forms the base of the Bath Oolite in certain localities of the counties of Oxford, Gloucester, and Northampton. It is typically developed at Stonesfield, near Woodstock, and consists of a finely laminated calcareous sandstone, and although of very inconsiderable thickness, rarely exceeding one foot, was formerly of considerable local value for roofing-purposes. It is not exposed in open quarries, but worked by means of shafts and galleries, the latter extending to a considerable distance from the mouths of the pits. The blocks of slate when first raised are very compact, but after being exposed to the action of frost split readily along the planes of bedding. The organic remains are numerous and varied, including several orders of plants. The plants are for the most part terrestrial, and include such forms as Pterophyllum, Zamia, and Sphenopteris. The small extreme branches of coniferous shrubs allied to the cypress and yew, which have received the name of Thuytes, occur also. Several genera of insects are among the rarer fossils. The Mollusca are but limited in species. The fishes of Stonesfield belong entirely to the Placoid and Ganoid orders. The remains of this kind are palatal teeth of the genera Strophodus and Pycnodus, teeth of Hybodontidæ and Sauroidei. The most famous of the Stonesfield reptiles is the *Megalosaurus Bucklandi.* There is also one species of Teleosaurus, and one of Pterodactyle, and one small species of Chelonia. The remarkable catalogue of associated life exhibited by this formation is rendered still more complete by three genera of small Mammalia. The Northamptonshire equivalent of this bed is a deposit of ferruginous sand and ironstone, termed Northampton sand. It is worked as an iron-ore near Blisworth. Its fossils are very scarce, and for the most part fragmentary; those from the Duston pits being the only ones that are sufficiently well preserved for identification. From the fact of this Northampton sand resting on the Upper Lias without any intervening beds, some geologists have been disposed to regard it as the equivalent of the Upper Lias sand of Gloucestershire, but the author considers the evidence not to be in favour of this opinion, as all the species hitherto collected are identical with those of the Stonesfield Slate.

"On a Fossil Elytrum from the Stonesfield Slate." By Mr. C. S. Gregson. The author stated that this wing-cover could not be referred to Buprestidæ, but is undoubtedly a Longicorne, and nearly allied to, though not identical with, *Prionus coriarius* of the present day, which has the elytra roughly punctured and three obscure raised lines, whilst the specimen under consideration has the whole surface divided equidistantly with more deeply sunk lines, and one well-defined mark on the side, carried down to the end of the wing-case. Specimens from South America so nearly approach the fossil in form that the author thought it advisable to give it the provisional name of *Prionaroides Hortoni.*

"On the Surface Markings near Liverpool, supposed to have been caused by Ice." By G. H. Morton, F.G.S. Towards the end of 1859 the author gave an account, to the Literary and Philosophical Society of Liverpool, of certain indications of ice passing over and grooving the rocks in Toxteth Park. Since that time he has found the same appearances in two other places. The following are the three localities:—In a field between Park Hill Road and the Dingle; in the brickfields, about 50 yards north of Boundary Street and 150 yards west of Gore Street, where about 10 yards of striated surface have been exposed for some years. The Sandstone belongs to the base of the "Keuper" formation. The surface inclines about 5° in the same direction as the grooves and furrows, N. 15° W. The elevation above the sea is about 80 feet. The other locality is also in the brickfields, about 600 yards S.W. of Kirkdale Gaol, and about the same distance from that last referred to, with which it may possibly communicate. The Sandstone belongs to the base of the "Keuper," and the striated surface exposed is fully 500 square yards, inclining throughout at an angle of $7\frac{1}{2}°$ in the direction of the striæ, which is the same as in the contiguous example, N. 15° W. The elevation above the sea is 80 feet, or perhaps a little less.

Since this communication was read, the author has found very distinct ice-grooves at Oxton, Cheshire, half a mile S.E. from the telegraph on Bidston

Hill. The direction of the striations is N. 30° W., and the elevation *about* 120 feet above high-water level.

"On the Thickness of the Bunter and Keuper Formations in the Country around Liverpool." By G. H. Morton, F.G.S. The author gave the results of recent measurements of the Triassic strata around Liverpool, and exhibited a section of the Keuper Sandstone of Storeton and Wapping tunnel. The following shows the results that he had obtained:—Keuper formation—Red Marl, 100 feet; Upper Shales, or Waterstone, 75 feet; Upper Sandstone, red and yellow, 150 feet; Lower Shales, 50 feet; Lower Sandstone, yellow and white, with conglomerate base, 175 feet: Bunter formations—Upper soft yellow Sandstone, 100 feet; Upper soft red and variegated Sandstone, 300 feet; Pebble-beds, 350 feet; Lower soft red and variegated Sandstone, base yellow, 400 feet; total, 1700 feet. The Upper Shales may be above 75 feet; that is the apparent thickness. The Lower soft red and variegated Sandstone may possibly exceed 400 feet, for its actual base is not seen.

Obituary Notice.

THE REV. STEPHEN HISLOP,

OF NAGPUR.

We sincerely regret to see a paragraph in the newspapers announcing the decease of the Rev. Stephen Hislop, of Nagpur, Missionary of the Free Church of Scotland, who was drowned, near Nagpur, on the evening of September 4th of this year. He was not only a highly esteemed Christian minister and most amiable man, possessing great influence with the natives of Central India, but he was also a good geologist, hard-working, clear-sighted, and cautious.

Several years ago (1853) the Rev. S. Hislop and his then colleague, the Rev. R. Hunter, observed that the tablets of reddish sandstone that served the native school-children for "slates" bore fossil remains of plants; and tracing the stones to the quarry from which they were obtained, they discovered abundant vegetable fossils; and, collecting them with care, they sent a large series of specimens to the Geological Society of London, most of which have been since described (in 1861), by Sir C. Bunbury, in the Society's Journal. They also made a careful examination of the geological characters of the vicinity of Nagpur, collected all the information they could from memoirs and notices by early labourers in Indian geology, and sent a large collection of Tertiary plant-remains, shells, insects, fishes, and bones, as well as rock-specimens and minerals, from the Nagpur territory to the Geological Society. Before long, in 1854, Messrs. Hislop and Hunter communicated to that Society a memoir, giving their views as to the geological structure of that country; and an abstract was published in the tenth volume of the Geol. Soc. Quart. Journ., and the memoir, in full, appeared in the eleventh volume, with a geological map of the western part of the Nagpur territory by the authors. Amendments of the map were subsequently communicated by Mr. Hislop; and in 1855 he sent home a short notice on the Umret Coalfield, lying north of Nagpur, and related by synchronism to the plant-beds of the latter district, as well as to the Burdwan and other coals of Bengal. Having come to England, in 1859, Mr. Hislop undertook the description of the Tertiary shells that he and Mr. Hunter had formerly sent home, as well as others that he now brought, both from the vicinity of Nagpur and from Rajamandri; and the results of this labour of love appeared as a memoir in the 'Journal of the Geological Society,' vol. xvi., illustrated with six plates, chiefly from his own drawings. The fossil insects and Cypridæ of Nagpur were at the same time described by his friends A. Murray, F.R.S.E., and Rupert Jones, F.G.S.

Returning to India early in 1861, he wrote a succinct account of his views of the age and relationship of the red sandstones, coal, and other beds of Central India, on board the steamer, and communicated it to the Geological Society as a companion paper to Sir C. Bunbury's memoir on the fossil plants of Nagpur and Mangali, both appearing in the seventeenth volume of the Society's journal. Later in the same year an extract from one of his letters appeared in the same journal (vol. xviii.), on the age of the Kotah limestone, which lies on sandstone containing plant-remains, and equivalent to that near Nagpur.

Mr. Hislop had also communicated the results of his geological researches to the Bombay Asiatic Society's Journal; his latest memoir in that work, we believe, is in vol. vi.

The results of the geological labours of our deceased friend are of much importance in the natural history of Central India, and, indeed, throw light on the age of the coal-series of Bengal also. The great fern-leaves, stems of trees, and other plant-remains from near Nagpur; the plants and reptiles, fishes and Estheriæ from Mangali; the Ceratodi from Maledi; the fishes and other fossils from Kotah, as well as the manifold fossil forms from the Tertiary beds of the Deccan, all help, or will help, in indicating the relative ages of the Indian strata, and putting them in geological order, adding knowledge for the scientific geologist, and, thereby, guidance for the practical man.

The earnestness and clearness of his work, whether in the field or at home, were equalled by Mr. Hislop's desire to be just to fellow-labourers and earlier observers, and by his modest avoidance of notoriety as a geologist and naturalist. With his equally enlightened colleague he had gleaned much in the Nagpur field of natural history, and when, after the Indian rebellion (during which a friendly native warned him in time to save Nagpur from the threatened evil), he lost his colleague,—retiring with broken health,—he still gave all the leisure that he conscientiously could spare from his more important duties to collecting and observing, his periodical tours of inspection and instruction affording almost his only opportunities. A faithful native, Vira, served him as a collector, being occasionally sent to considerable distances for fossils. At one of Vira's last visits to Maledi (1863), he discovered a valuable series of reptilian bones and teeth.

As helps in studying the fossil forms of life in India, Mr. Hislop lost no opportunity of collecting and observing recent animals and plants of kinds similar to the extinct; and these he freely communicated to naturalists in India and England. Some small bivalve Crustacea collected by him from the ponds and streams of Nagpur have been described by Dr. Baird, and allied fossil forms from Naghur and Mangali by Mr. Rupert Jones.

Taken away suddenly from his family, his friends, and his native church and schools, he will live in our memory as a beloved man, just and good, and as an acute observer, cautious and conscientious; not courting praise, nor even notice, but delighting in work and truth as a loving student of nature and a faithful servant of God. T. R. J.

FOREIGN INTELLIGENCE.

The question of the "Terrain Quaternaire" and the antiquity of man in the north of France, discussed at the Academy of Sciences on the occasion of the discovery of the human jaw at Moulin-Quignon, has been treated in detail by M. d'Archiac in his Museum lectures, now collected and published by M. Trutet. M. d'Archiac does not share in the opinion of M. Elie du Beaumont upon the general question of the degree of antiquity of the human species, and relatively to the special case of the Moulin-Quignon jaw, he does not support the opinion of the learned Perpetual Secretary of the Academy as to the nature of the deposit. He believes there is nothing in the least to justify the assertion that it is one of those which come within the denomination of "meubles sur les pentes." The deposits on the declivities, if they are due to floods and torrential waters, display a particular structure, and require hollows in the soil which do not exist in that district, and those which might be attributed to occasional erosions of the rivers do not accord with the lines of ancient talus, but on the contrary, with common modern deposits. Moreover, the analogy of the deposit at Moulin-Quignon with those of other neighbouring localities incontestably quaternary does not permit a separation. The discovery of the human jaw of Moulin-Quignon, whatever its authenticity, has in reality but a secondary importance; it is a simple fact confirming proofs of much greater value by their number and generality. If the worked flints cannot really be attributed to chance, if they are really the produce of human industry, if they can be regarded as the evidence equally indisputable, of the existence of man before the formation of the deposit which contains them,—as the bones of elephants, rhinoceros, the great deer, hippopotamus, bear, hyæna, cave-lion, etc., are of the contemporary existence of those animals,—it matters little whether we meet with, or do not meet with the remains of man himself; the question is resolved by the fact, and it matters little primarily whether the sand and the solid gravel of Moulin-Quignon be or be not quaternary. The general essential result, the theoretical point which governs the question, namely, the antiquity of man and his contemporaneity with the great extinct species of mammifers, would not be affected, and the conclusion would lose nothing of its value from being founded on the produce of human industry, instead of upon the remains of man's skeleton. Regarding the facts acquired, we cannot refuse to admit that the worked flints of Amiens and Abbeville are found in a deposit essentially quaternary, associated with the bones of animals of extinct species, and except from particular circumstances there is no reason to suspect the human jaw of Moulin-Quignon should not be contemporary. Now however it remains to treat an essential point—the precise determination of the age of those deposits or the place they occupy in the quaternary series. This determination M. Archiac thinks very easy. Not by seeking on the South terms of comparison where none exist, or of which, if they did, we could not admit the value, but by going to the North-west in the Low Countries where the quaternary series above and below the level of the sea is to be seen in its true relations with the Upper Tertiary deposits; or, better still, to the north in the eastern counties of England. In the particular basin of the Somme, as in all the little depressions which follow the watercourses which run from the divisional line of the Oise directly to the sea, the deposits of transported detritus, ooze (*limoneux*), sand, and gravels repose directly on the Chalk, excepting where the

Lower Tertiary deposits separate them, and we perceive no intermediate stratum sufficiently characterized to admit our appreciating the immensity of time which elapsed before these recent sediments were superposed. But beyond that district the original flint-implement stratum, identical with that of the valley of the Somme, is found in the lacustrine beds which have succeeded the partial scooping out (*ravinement*) of the till or boulder-clay. The evidence of these relations has been given by the sections at Hoxne, in Suffolk, the valley of the Lark, at Bedford, etc., compared with those of Mundesley, on the Norfolk coast. These have demonstrated to us that the lacustrine beds are more recent than the marine quaternary deposits of England, Scotland, and Ireland, and still more so than the Norfolk Crag, the masses of bones of *Elephas meridionalis* and *E. antiquus*, and lastly than the phenomena of striation, groovings, and polished surfaces of the northern regions, whether in the British Islands or in Scandinavia. The fauna which characterizes these sediments, where industrial products for the first time appear, consists of fluviatile and terrestrial mollusca,—which, with two or three exceptions, still live in the district,—and of pachydermatous mammalia, ruminants, and carnivora—*Elephas primigenius, E. antiquus, Rhinoceros tichorhinus, Hippopotamus major, Cervus tarandus, C. megaceros, Bos primigenius, B. moschatus, Equus fossilis, Felis spelæa, Hyæna spelæa, Ursus spelæus*, etc.; that is, precisely the association of species which we find in the fluvio-marine deposits of Menchecourt, in the sand and gravel drift deposits (*terrains de transport*) of other localities around Abbeville, Amiens, as well as in the valley of the Oise, in the environs of Chauny, etc. The analogy of these faunas, between one part and the other of the region, is rendered still more striking by the presence at Menchecourt of the *Corbicula consobrina* or *fluminalis*, so characteristic of the same horizon from Grays Thurrocks, on the left bank of the Thames, as far as the neighbourhood of Hull, on the borders of the Humber, and which has been observed at the same horizon in well-sinkings at Ostend.

Now the débris of this fauna of vertebrates and invertebrates has been buried since the spreading of the great deposits of sand, clay, and rolled pebbles, which extends from the east and south parts of England, and to which succeeds also, in some parts of the Continent, an argillaceous sand analogous to the ancient alluvium. If with these known stratigraphical and palæontological divisions on the other side of the straits, we specially compare those of the valley of the Somme, we shall be led to regard the quaternary deposits of the latter as not more ancient than the lacustrine beds of England, as contemporary with those that beyond the Channel contain the fauna of great extinct mammalia which lived towards the middle of the Quaternary epoch. The deposits of the valley of the Somme, like those of the basins of the Oise, more recent than the boulder-clay (*argile à blocs*), than the crag of Norfolk, represent, in reality, only the phenomena which preceded the second glacial period. Thus on the one part the comparison of these deposits with those of the neighbouring departments to the east, and where the stratigraphical relationships are better marked, permits a statement of the period to which they belong; on the other hand, their comparison with those of Belgium, Holland, and England, reveals their true place or exact horizon in the series of sediments of this age. "We distinguish thus," says M. d'Archiac, "with M. Worsaae, two ages of stone; one anterior to the last quaternary deposits, or *antediluvian*, characterized by the most rudely worked flints; the other, posterior or *antehistoric*, the arms or instruments of which belong to a more or less barbaric state, the age of which comes up to the ancient peoples of Denmark, who formed the Kjökkenmöddings, and those of Switzerland, Ireland, and other regions, who constructed their lake-dwellings."

M. Raynal, Professor of Physics at Poitiers, has discovered the remains of a crocodile in the oolite of Grand-Pont. The lower jaw is like that of *C. Schlegelii* of Blainville (Ostéog. p. 5, pl. ii.). The opercular bones extend as far as the symphysis, a character unknown in any other crocodile. In allusion to these conditions, the specimen has been termed *C. physognathus.*

NOTES AND QUERIES.

Mammalian Remains.—The following passage in Bishop Gibson's translation (ed. 1772) of Camden's 'Britannia,' seemingly refers to Mammalian remains, and possibly to fossil flint implements :—" After the Wye has run a little further and saluted Goodrich Castle, which King John gave to William, Earl-Marshal, and which was afterwards the principal seat of the Talbots, it takes leave of Herefordshire, and goes into the county of Monmouth. In the south limit of this county is Doward, in the parish of Whitchurch, a pretty high hill, on the top whereof one would guess by the ditches that there had been an ancient fortification; and what makes it probable is that in digging there for iron-ore and limestone, *broad arrowheads* have been found of late years, and not long ago the greatest part of the *bones of a gigantic person* were found here interred in a place which seemed to be arched over: the length of all the joints was twice the length of others of this age, and they were given by two neighbouring gentlemen, Captain Scudamore and Mr. White, to a surgeon in Bristol."

Professor R. Jones on Foraminifera.—For the 6th paragraph on page 294, and the second footnote, substitute the following :—

Fig. 9–11. Rotalia* umbilicata, *D'Orbigny*, sp.

This is a small compact variety of *Rotalia Beccarii*, and is almost, if not quite, the same as *Rotalia Soldanii*. *R. Beccarii* lives in rather shallow water, and some of its varieties live in very shallow water, even in river-mouths and salt-marshes; whilst *R. umbilicata* is found in deeper water than the type lives in; and *R. orbicularis*, another variety, is smaller still, and exists in deeper parts of the sea, from a hundred to a thousand fathoms.

MISCELLANEOUS NOTICES.

'Silliman's Journal' for July contains "Observations upon some of the Brachiopoda, with reference to the genera *Cryptorella*, *Centronella*, *Meristella*, and allied forms," by Professor James Hall; continuation of the "Flora of the Devonian period in North-Eastern America," by Dr. J. W. Dawson; "New Facts and Conclusions respecting the Fossil Footmarks in the Connecticut Valley," by Edward Hitchcock; "On Aerolites and the fall of Stones at Butsura, India, May, 1861," by Professor N. S. Maskelyne. The new works or works preparing for publication noticed are, Annual Report of the State Geologist of California for 1862; Map of Bay of St. Francisco; Map of vicinity of Mount Diablo; Map of Coast-ranges from Bay of Monterey south to Santa Barbara; Map of the Washoe Silver-mining region; Map of Comstock Lode; Map of central portion of Sierra Nevada; 'Ichnographs from the Sandstone of Connecticut River,' by James Deane, M.D., 62 pp. 4to, with 45 plates; 'Notice of some new species of Fossils from a locality of the Niagara group in Indiana, with a list of identified species from the same place,' by Professor James Hall; 'Die Ctenodipterinen des Devonischen Systems,' by Dr. C. H. Pander (St. Petersburg, 1858); 'Ueber die Saurodipterinen, Dendrodonten, Glyptolepiden, und Cheirolepiden des Devonischen Systems,' by Dr. C. H. Pander (1860). The height of Mount Shasta, in California, has been fixed at 14,440 feet, by Mr. Whitney, the geological surveyor.

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* For the description of *Rotalia* proper, see Carpenter's 'Introduction to the Study of Foraminifera' (Ray Society), 1862, p. 212, etc.

The September number of that journal has the following geological articles:—"On the Coal-Measures of Cape Breton, N.B.," with a section, by Mr. J. P. Lesley; "On the Genus Centronella," by Mr. E. Billings; "On Childrenite, from Hebron, in Maine," by Mr. George J. Brush; "On Meteoric Iron from Dakota Territory," by Dr. C. T. Jackson, of Boston. Amongst the notices of new works are—

Zusammenstellung der Statischen Ergebnisse des Bergwerks, Hütten- und Salinen-Betriebes in dem Preussischen Staate während der zehn Jahre von 1852 bis 1861. By E. Althaus. Berlin, 1853.——Handbuch der Metallurgischen Hüttenkunde, vol. ii. By Bruno Kerl. Freiberg, 1863.——État présent de la Métallurgie du Fer en Angleterre. By MM. Gruner et Lan. Paris, 1862.——Berg- und Hüttenmännisches Jahrbuch der k. k. Bergakademien Leoben und Schemnitz, und der k. k. Montan-Lehranstalt, Pribram Redakteur. P. Turner. Vienna, 1863.——Die Fortschritte der Metallurgischen Hüttengewerbes im Jahre 1862. By Dr. C. F. A. Hartmann. Leipzig, 1863.——International Exhibition of 1862, Jurors' Report of Class I., Mining, Quarrying, Metallurgy, and Mineral Products. By W. W. Smyth, F.R.S. London, 1862.——Second Annual Report upon the Natural History and Geology of the State of Maine. 1862. Published 1863.——Fossil Crustaceans from the Coal-Measures and Devonian Rocks of British America. By Mr. Salter. In Q. J. Geol. Soc., vol. xix.——On the Cambrian and Huronian Formations. By Dr. J. J. Bigsby. In Q. J. Geol. Soc., vol. xix.——On the Lower Carboniferous Brachiopoda of Nova Scotia. By T. Davidson, Esq. In Q. J. Geol. Soc., vol. xix.——On the Fossil Estheriæ and their Distribution. By Professor T. Rupert Jones. In Q. J. Geol. Soc., vol. xix.——On a new Labyrinthodont Reptile, *Anthracosaurus Russelli*, from the Lanarkshire Coal-Field. By Professor T. H. Huxley. In Q. J. Geol. Soc., vol. xix.——On the Production of Crystalline Limestone by Heat. In Poggendorf, Ann., vol. cxviii.——On the Flora of the Devonian Period in North-Eastern America. By Dr. J. W. Dawson. In Q. J. Geol. Soc., 1862.

The 'Dublin Quarterly Journal of Science' for October contains a very interesting "Description of the Tonymore Crannoge," by Mr. W. R. Wilde, with woodcut plans and views; a paper "On some Striated Surfaces in the Granite near Dublin,' by the Rev. M. Close,—the striations referred to being on the vertical faces of joints, and resembling Slickenslides; a "Description of a New Species of Plesiosaurus from the Lias, near Whitby," by Dr. A. Carte and Mr. W. H. Baily, with two plates, —this Plesiosaurus being the very large and perfect one found on the estate of the Marquis of Normanby, in July, 1848, in the Liassic beds of the Kettleness Alum Works, and presented by that nobleman to the late Sir Philip Crampton, Bart., and now in the Natural History Museum of the Royal Dublin Society. The name given to this specimen by the author is *P. Cramptoni*.

REVIEWS.

Air-breathers of the Coal Period; a descriptive account of the Remains of Land-Animals found in the Coal Formation of Nova Scotia, with remarks on their bearing on theories of the formation of Coal, and of the Origin of Species. By J. W. Dawson, LL.D., F.R.S., F.G.S., etc., Principal of M'Gill University, Montreal.

To Dr. Dawson geology is indebted for much progress in the knowledge obtained of the fossil botany of the Palæozoic period, but his discoveries of reptilian remains and of air-breathing land-shells in the coal strata of Nova Scotia, are discoveries in value far beyond the usual estimation of new species and genera. They are fixed points in the scale of progress in our science,—distinct steps in the ladder of human information; they teach important conclusions, and, rightly, their discoverer feels himself under an obligation to make them known as extensively and perfectly as possible to the scientific world. Although already the specimens have been more or less extensively illustrated in the pages of the 'Journal of the London Geological Society,' and have been submitted to the investigation specially engaged in the study of such remains, Dr. Dawson has found it impossible to bring out in this way all the details desirable, and to present a connected view of the facts. Hence the present publication, which is a revised reprint of articles published during the present year in the 'Canadian Naturalist and Geologist,' and illustrated with, besides the plates given in that journal, a photograph-plate of details of various Dendrerpetons and Hylonomi. Those who wish minutely to study this interesting subject, we must refer to Dr. Dawson's valuable *brochure;* but we may here well give a brief abstract of its contents, and in doing this we shall show a more marked appreciation of the doctor's labours than by any amount of laudatory comments we could bestow. The animal population of the earth during the older or palæozoic period is known to us chiefly through the medium of remains preserved in rocks deposited on the bed of the ocean, in which there is but slight chance of finding relics of the animals of the land, even if such had existed plentifully on its bounding shores. Perhaps for this reason—perhaps because there were no land-animals—the organic remains of the Cambrian, Silurian, and Lower Devonian rocks contain, so far as animal remains are concerned, only those of marine species. In the Upper Silurian and Lower Devonian, however, land plants begin to appear; and in the Upper Devonian these are so numerous and varied as to afford a great probability that animals also tenanted the land. Indeed, Mr. Hartt, of St. John, has informed the author of the discovery of insect-remains on the rich plant-bearing Upper Devonian beds of that locality. It is true, also, that reptiles of high organization have been found in beds referred to the Upper Devonian, at Elgin, in Scotland. That there was dry land even in the Lower Silurian period, we know, and can even trace the former shores. In Canada the old Laurentian coast extends for more than a thousand miles from Labrador to Lake Superior, marking the southern border of the nucleus of the American continent in the Lower Silurian period. Along a great part of this ancient coast are other sand-flats of the Potsdam sandstone, affording very favourable conditions for the embedding of land-animals, had such existed; still not a trace has been found.

"I have myself," says Dr. Dawson, "followed the Lower Silurian beds up to their ancient limits in some localities, and collected the shells which the waves had dashed on the beach, and have seen under the Silurian beds, the Laurentian rocks pitted and indented with weather marks, showing that this old shore was then gradually subsiding;

yet the record of the rocks was totally silent as to the animals that may have trod the shore, or the trees that may have waved over it. All that can be said is that the sun shone, the rain fell, and the wind blew as it does now, and that the sea abounded in living creatures. The eyes of trilobites, the weathered Laurentian rocks, the wind-ripples in the Potsdam sandstone, the rich fossils of the limestones, testify to these things. The existence of such conditions would lead us to hope that land animals may yet be found in these older formations. On the other hand, the gradual failure of one form of life after another, as we descend in the geological series, and the absence of fishes and land plants in the older Silurian rocks, might induce us to believe that we have here reached the beginning of animal life, and have left far behind us those forms that inhabit the land.

"Even in the Carboniferous period, though land plants abound, air-breathers are few, and most of them have only been recently recognized. We know, however, with certainty that the dark and luxuriant forests of the Coal period were not destitute of animal life. Reptiles crept under their shade, land-snails and millipedes fed on the rank leaves and decaying vegetable matter, and insects flitted through the air of the sunnier spots. Great interest attaches to these creatures; perhaps the first-born species in some of their respective types, and certainly belonging to one of the oldest land faunas, and presenting prototypes of future forms equally interesting to the geologist and the zoologist.

"It has happened to the writer of these pages to have had some share in the discovery of several of these ancient animals. The coal formation of Nova Scotia, so full in its development, so rich in fossil remains, and so well exposed in coast cliffs, has afforded admirable opportunities for such discoveries, which have been so far improved that at least eight out of the not very large number of known Carboniferous land animals, have been obtained from it."

Five species of Carboniferous reptiles have been recognized on the continent of Europe, three in Great Britain, and four in the United States of America. Footprints were amongst the earliest indications of the Carboniferous reptiles of Nova Scotia:—

"It has often happened to geologists, as to other explorers of new regions, that footprints on the sand have guided them to the inhabitants of unknown lands. The first trace ever observed of reptiles in the Carboniferous system, consisted of a series of small but well-marked footprints found by Sir W. E. Logan, in 1841, in the lower coal-measures of Horton Bluff, in Nova Scotia.

"The rocks of Horton Bluff are below the gypsum of that neighbourhood; so that the specimen in question (if Lyell's views are correct) comes from the very bottom of the coal series, or at any rate very low down in it, and demonstrates the existence of reptiles at an earlier epoch than has hitherto been determined; none having been previously found below the magnesian limestone, or to give it Murchison's new name, the 'Permian era.'

This important discovery, made in 1841, and published in 1842, has been overlooked by European writers:—

"And the discovery of reptilian bones by Von Dechen, at Saarbruck, in 1844, and that of footprints by Dr. King in the same year, in Pennsylvania, have been uniformly referred to as the first observations of this kind. This error Dr. Dawson desires to correct, not merely in the interest of truth, but also in that of his friend Sir William Logan, and of his native province of Nova Scotia; and he trusts that henceforth the received statement will be, that the first indications of the existence of reptiles in the Coal period, were obtained by Logan, in the lower coal formation of Nova Scotia, in 1841. Insects and arachnidans, it may be observed, had previously been discovered in the coal formation in Europe.

"The original specimen of these footprints is still in the collection of Sir William Logan. It is a slab of dark-coloured sandstone, glazed with fine clay on the surface; and having a series of seven footprints in two rows, distant about three inches; the distance of the impressions in each row being three or four inches, and the individual impressions about one inch in length. They seem to have been made by the points of the toes, which must have been armed with strong and apparently blunt claws, and appear as if either the surface had been somewhat firm, or as if the body of the animal had been partly water-borne. In one place only is there a distinct mark of the whole foot, as if the animal had exerted an unusual pressure in turning or stopping suddenly. The impressions are such as may have been made by some of the reptiles to be described in the sequel, as, for instance, by *Dendrerpeton Acadianum.*

"Attention having been directed to such marks by these observations of Sir William Logan, several other discoveries of the same kind were subsequently made, in various parts of the province, and in different members of the Carboniferous system. The first of these, in order of time, was made in 1844, in beds of Red Sandstone and shale near Tatamagouche, in the eastern part of Nova Scotia, and belonging to the upper or newer members of the coal-measures. In examining these beds with the view of determining their precise geological age, Dr. Dawson found on the surface of some of them impressions of worm-burrows, rain-drops, and sun-cracks, and with these, two kinds of footprints, probably of reptilian animals. One kind consisted of marks, or rather scratches, as of three toes, and resembling somewhat the scratches made by the claws of a tortoise in creeping up a bank of stiff clay; they were probably of the same nature and origin with those found by Logan at Horton. The others were of very different appearance. They consisted of two series of strongly-marked elongated impressions, without distinct marks of toes, in series four inches distant from each other, and with an intervening tail-mark. They seem to have been produced by an animal wading in soft mud, so that deep holes, rather than regular impressions, marked its footsteps, and that in the hind foot, the heel touched the surface, giving a plantigrade appearance to the tracks.

"Shortly afterward, Dr. Harding, of Windsor, when examining a cargo of sandstone which had been landed at that place from Parrsboro', found on one of the slabs a very distinct series of footprints each with four toes, and a trace of the fifth. The rocks at that place are probably of nearly the same age with those of Parrsboro'. Similar footprints are also stated to have been found by Dr. Gesner, at Parrsboro'. Dr. Dawson has since observed several instances of such impressions at the Joggins, at Horton, and near Windsor; these examples showing that reptilian animals existed in no inconsiderable numbers throughout the coal-field of Nova Scotia, and from the beginning to the end of the Carboniferous period. On comparing these with one another, it will be observed that Logan's, Harding's, and one of mine are of similar general character, and may have been made by one kind of animal, which must have had the fore and hind feet nearly of equal size. The other belongs to a smaller animal, which probably travelled on longer limbs, more in the manner of an ordinary quadruped. These impressions are chiefly interesting as indicating the wide diffusion and abundance of the creatures producing them, and that they haunted tidal flats and muddy shores, perhaps emerging from the water that they might bask in the sun, or possibly searching for food among the rejectamenta of the sea, or of lagunes and estuaries."

In 1851 Dr. Dawson discovered, in a large pile of rubbish, at the Albion Mines Railway Station in some blocks of hard carboniferous shale and earthy coal, scales, teeth, and coprolites. Observing an object of larger size than usual at the edge of a block, he split the block open and found a large flattened skull, which was dispatched to England, and after remaining a year or two as quietly in the Geological Society's collection as if in its original bed in the coal-mine, it was handed, in 1852, to Professor Owen, who described it in December, 1853, under the name of *Baphetes planiceps*, or the "flat-headed diving animal," in allusion to the flatness of the creature's skull, and the possibility of its having been in the habit of diving:—

"Of the general form and dimensions of Baphetes, the facts at present known do not enable us to say much. Its formidable teeth and strong maxillary bones show that it must have devoured animals of considerable size, probably the fishes whose remains are found with it, or the smaller reptiles of the Coal. It must in short have been crocodilian, rather than frog-like, in its mode of life; but whether, like the labyrinthodonts, it had strong limbs and a short body, or like the crocodiles, an elongated form and a powerful natatory tail, the remains do not decide. One of the limbs or a vertebra of the tail

> would settle this question, but neither have as yet been found. That there were large animals of the labyrinthodontal form in the Coal period, is proved by the footprints discovered by Dr. King in Pennsylvania, which may have been produced by an animal of the type of Baphetes. On the other hand, that there were large swimming reptiles, seems established by the recent discovery of the vertebræ of *Eosaurus Acadianus*, at the Joggins, by Mr. Marsh. The locomotion of Baphetes must have been vigorous and rapid, but it may have been effected both on land and in water, and either by feet or tail, or both.
>
> "With the nature of its habitat we are better acquainted. The area of the Albion Mines coal-field was somewhat exceptional in its character. It seems to have been a bay or indentation in the Silurian land, separated from the remainder of the coal-field by a high shingle beach, now a bed of conglomerate.
>
> "We may imagine a large lake or lagune, loaded with trunks of trees and decaying vegetable matter, having in its shallow parts, and along its sides, dense brakes of Calamites, and forests of Sigillaria, Lepidodendron, and other trees of the period, extending far on every side as damp pestilential swamps. In such a habitat, uninviting to us, but, no doubt, suited to Baphetes, that creature crawled through swamps and thickets, wallowed in flats of black mud, or swam and dived in search of its finny prey. It was, in so far as we know, the monarch of these swamps, though there is evidence of the existence of similar creatures of this type quite as large in other parts of the Nova Scotia coalfield."

The first discovery of the remains of a reptile, the *Dendrerpeton Acadianum*, and a land-shell in the interior of a great tree in the coal-measures of Nova Scotia, was primarily announced in a joint paper by Dr. Dawson and Sir Charles Lyell, before the Geological Society of London:—

> "The South Joggins Section is, among other things, remarkable for the number of beds which contain remains of erect trees embedded *in situ:* these trees are for the most part Sigillariæ, varying in diameter from six inches to five feet. They have grown in underclays and wet soils, similar to those in which the coal was accumulated; and these having been submerged or buried by mud carried down by inundations, the trees, killed by the accumulations around their stems, have decayed, and their tops being broken off at the level of the mud or sand, the cylindrical cavities, left open by the disappearance of the wood, and preserved in their form by the greater durability of the bark, have been filled with sand and clay. This, now hardened into stone, constitutes pillar-like casts of the trees, which may often be seen exposed in the cliffs, and which, as these waste away, fall upon the beach. The sandstones enveloping these pillared trunks of the ancient Sigillariæ of the coal, are laminated or bedded, and the laminæ, when exposed, split apart with the weather, so that the trees themselves become split across; this being often aided by the arrangement of the matter within the trunks, in layers more or less corresponding to those without. Thus one of these fossil trees usually falls to the beach in a series of disks, somewhat resembling the grindstones which are extensively manufactured on the coast. The surfaces of these fragments often exhibit remains of plants which have been washed into the hollow trunks and have been embedded there; and in our explorations of the shore, we always carefully scrutinized such specimens, both with the view of observing whether they retained the superficial markings of Sigillariæ, and with reference to the fossils contained in them. It was while examining a pile of these 'fossil grindstones,' that we were surprised by finding on one of them what seemed to be fragments of bone. On careful search other bones appeared, and they had the aspect, not of remains of fishes, of which many species are found fossil in these coal-measures, but rather of limb-bones of a quadruped. The fallen pieces of the tree were carefully taken up, and other bones disengaged, and at length a jaw with teeth made its appearance. We felt quite confident, from the first, that these bones were reptilian; and the whole, being carefully packed and labelled, were taken by Sir Charles to the United States, and submitted to Professor J. Wyman, of Cambridge, who recognized their reptilian character, and prepared descriptive notes of the principal bones, which appeared to have belonged to two species. He also observed among the fragments an object of different character, apparently a shell, which was recognized by Dr. Gould, of Boston, and subsequently by Mr. Deshayes, as probably a land-snail, and has since been named *Pupa vetusta*.

"The specimens were subsequently taken to London and re-examined by Professor Owen, who confirmed Wyman's inferences, added other characters to the description, and named the larger and better preserved species *Dendrerpeton Acadianum*, in allusion to its discovery in the interior of a tree, and to its native country of Acadia, or Nova Scotia.

"In form, *Dendrerpeton Acadianum* was probably lizard-like; with a broad flat head, short stout limbs, and an elongated tail; and having its skin, and more particularly that of the belly, protected by small bony plates closely overlapping each other. It may have attained the length of two feet. The form of the head is not unlike that of Baphetes, but longer in proportion, and much resembles that of the labyrinthodont reptiles of the Trias.

"This ancient inhabitant of the coal-swamps of Nova Scotia, was, in short, as we often find to be the case with the earliest forms of life, the possessor of powers and structures not usually, in the modern world, combined in a single species. It was certainly not a fish, yet its bony scales, and the form of its vertebræ, and of its teeth, might, in the absence of other evidence, cause it to be mistaken for one. We call it a batrachian, yet its dentition, the sculpturing of the bones of its skull, which were certainly no more external plates than the similar bones of a crocodile, its ribs, and the structure of its limbs, remind us of the higher reptiles; and we do not know that it ever possessed gills, or passed through a larval or fish-like condition. Still, in a great many important characters, its structures are undoubtedly batrachian. It stands, in short, in the same position with the Lepidodendra and Sigillariæ, under whose shade it crept, which, though placed by palæo-botanists in alliance with certain modern groups of plants, manifestly differed from these in many of their characters, and occupied a different position in nature. In the Coal period, the distinctions of physical and vital conditions were not well defined; dry land and water, terrestrial and aquatic plants and animals, and lower and higher forms of animal and vegetable life, are consequently not easily separated from each other. This is, no doubt, a state of things characteristic of the earlier stages of the earth's history, yet not necessarily so; for there are some reasons, derived from fossil plants, for believing that in the preceding Devonian period there was less of this, and consequently that there may then have been a higher and more varied animal life than in the Coal period. Even in the modern world also, we still find local cases of this early union of dissimilar conditions. It is in the swamps of Africa, at one time dry, at another inundated, that such intermediate forms as Lepidosiren occur, to baffle the classificatory powers of naturalists; and it is in the stagnant unaerated waters, half swamp, half lake or river, and unfit for ordinary fishes, that the semi-reptilian Amia and Lepidosteus still keep up the characters of their palæozoic predecessors.

"The dentition of Dendrerpeton shows it to have been carnivorous in a high degree. It may have captured fishes and smaller reptiles, either on land or in water, and very probably fed on dead carcases as well.

"All the bones of Dendrerpeton hitherto found, as well as those of the smaller reptilian species hereafter described, have been obtained from the interior of erect Sigillariæ, and all of these in one of the many beds, which, at the Joggins, contain such remains."

Amongst the other reptilian remains found in great trees at South Joggin are a smaller-sized species of Dendrerpeton, *D. Oweni*, the *Hylonomus Lyelli*, *H. aciedentatus*, *H. Wymani*, *H. Dawsoni*, and the *Eosaurus Acadianus*. The *Dendrerpeton Oweni* lived in the same places with its larger congener, but it may have differed somewhat in its habits; its longer and sharper teeth may have been better suited for devouring worms, larvæ, or soft-skinned fishes, while those of the larger *Dendrerpeton Acadianum* were better adapted to deal with the mailed ganoids of the period, or with the smaller reptiles, which were more or less protected with bony or horny scales. In the original reptiliferous tree discovered by Dawson and Lyell at the Joggins in 1861, there were, besides the *Dendrerpeton Acadianum*, some small elongated vertebræ, evidently of a different species. These were first detected by Professor Wyman in his examination of these specimens, and were figured, but not named in the notice in the 'Quarterly

Journal of the Geological Society.' In a subsequent visit, Dr. Dawson obtained from another erect stump many additional remains of these smaller reptiles, and, on careful comparison, was induced to refer them to three species, all apparently generically allied, and for which he proposed the name of Hylonomus or "forest-dweller." *Hylonomus Lyelli* was an animal of small size, of lacertian form, with large and stout hind limbs, capable of walking and running on dry land; and though its vertebræ were imperfectly ossified externally, yet their articulation was sufficiently firm to have enabled the creature to erect itself on its hind limbs or to leap. The ribs, long and much curved, imply a respiration of a higher character than that of modern batrachians, and consequently a more vitalized muscular system; if to these structural points we add the somewhat rounded skull, indicating a large brain, we have before us a creature which, however puzzling in its affinities when anatomically considered, is clearly not to be ranked as low in the scale of creation as modern tailed batrachians, or even as frogs and toads. The bony scales, moreover, with which it was armed below, and the ornate apparatus of horny appendages with which it was clad above, show that this little animal was not a squalid, slimy dweller in mud, like Menobranchus and its allies, but rather a beautiful and sprightly tenant of the coal-formation thickets, "vying in brilliancy and perhaps in colouring with the insects it pursued and devoured." The remains of as many as eight or ten individuals obtained from three erect Sigillariæ is an indication that these creatures were very abundant. *Hylonomus aciedentatus* was about twice as large as the species last described; its habits and food may have been similar, but its dental apparatus was stronger and more formidable. Of *Hylonomus Wymani* no complete remains have been found; it was very diminutive, all the fragments met with being almost microscopic in size. Its length could not have exceeded 4 or 5 inches, and its form was thin and slender. It might be questioned whether this little creature was not the young of one of the other species, but so far a comparison does not favour such a view.

> "*Hylonomus Wymani* probably fed on insects and larvæ, and searched for these among the vegetable débris of the coal-swamps, which would afford to a little creature like this abundant shelter. It occasionally fell a prey to its larger reptilian contemporaries; for quantities of its tiny bones occur in coprolitic masses, probably attributable to Dendrerpeton. It is interesting to find reptilian life represented at this early period, not only by large and formidable species, but by diminutive forms, comparable with the smallest lizards and newts of the modern world. The fact is parallel with that of the occurrence of several small mammalian species in the mesozoic beds. It will be still more significant in this respect if the species of Hylonomus should be found to be truly lacertian rather than batrachian."

The *Hylerpeton Dawsoni* was found by Dr. Dawson in the laminated material which fills the erect trees of the Joggins, the more distinctly separable surfaces of which are often stained with ferruginous or coaly matter, or fine clay, so that the fossils which occur on these surfaces are rendered so obscure as readily to escape observation. The specimen on which this species is established consisted of detached bones of a reptile scattered over a surface so blurred and stained, that they escaped notice until most of them were lost, and only fragments of the skull, a jawbone, and a few other bones, were secured. On these fragments Professor Owen founded the genus.

> "On the whole," says Dr. Dawson, "the Hylerpeton must have been generically distinct from the other reptiles found with it, and it is probable that it was of more aquatic habits, swimming rather than walking; and feeding principally on fish. More perfect

specimens would, however, be required in order to warrant any decided statement on these subjects. It is possible, as suggested by Professor Owen, that the affinities of the animal may be with Archegosaurus rather than with any of the other Coal reptiles; but I confess that my present impression is that it tends rather toward the genus Hylonomus. It may possibly be a link of connection between the Microsauria and the Archegosauria."

Besides the foregoing species, Mr. O. C. Marsh added, in 1861, a new animal to the Joggins reptilian fauna, the *Eosaurus Acadianus,*—a species founded on two large biconcave vertebræ, resembling, in many respects, those of Ichthyosaurus, and of which we have already given a notice in this magazine.

"The vertebræ of Eosaurus have been fully and ably described by Mr. Marsh in Silliman's Journal. Agassiz and Wyman regard their affinities as enaliosaurian. Huxley suggests the possibility, founded on his recent discovery of *Anthracosaurus Russelli,* that there may have been labyrinthodont batrachians in the Coal period with such vertebræ. However this may be, if the vertebræ were caudal, as supposed by Mr. Marsh, since they are about 2½ inches in diameter, they would indicate a gigantic aquatic reptile, furnished with a powerful swimming tail, and, no doubt, with apparatus for the capture and destruction of its prey, comparable with that of Ichthyosaurus."

Dr. Dawson next fully describes and discusses the conditions of life and habits of the invertebrate air-breathers, the *Pupa vetusta,* and the gully-worm or millipede, *Xylobius sigillariæ.* In his concluding remarks he attempts to reconcile many of the anomalies seemingly presented by the organic remains of the coal strata. We have already trenched too largely on our space to follow the Doctor through this portion of his excellent pamphlet, but there is one passage we may well transcribe:—

"In the coal-measures of Nova Scotia, therefore, while marine conditions are absent, there are ample evidences of fresh-water or brackish-water conditions, and of land-surfaces suitable for the air-breathing animals of the period. Nor do I believe that the coal-measures of Nova Scotia were exceptional in this respect. It is true that in Great Britain evidences of marine life do occur in the coal-measures; but not, so far as I am aware, in circumstances which justify the inference that the coal is of marine origin. Alternations of marine and land remains, and even mixtures of these, are frequent in modern submarine forests. When we find, as at Fort Lawrence in Nova Scotia, a modern forest rooted in upland soil forty feet below high-water mark, and covered with mud containing living Tellinas and Myas, we are not justified in inferring that this forest grew in the sea. We rather infer that subsidence has occurred. In modern salt marshes it is not unusual to find every little runnel or pool full of marine shellfish, while in the higher parts of the marsh land-plants are growing; and in such places the deposit formed must contain a mixture of land-plants and marine animals with salt grasses and herbage—the whole *in situ.*"

The above paragraph is important, because these considerations are intended to explain the apparently anomalous associations of coal-plants with marine fossils; and there are, perhaps, no other arguments of weight that can be adduced in favour of the marine origin of coal, except such as the Doctor asserts to be based on misconceptions of the structure and mode of growth of sigillaroid trees, and of the stratigraphical relations of the coal itself. To this he adds a judicious and significant reservation, fully in accordance with the opinions we have ourselves long since expressed, and while he maintains the essentially terrestrial character of ordinary coal and of its plants, he admits that cannel coals and earthy bitumen present evidence of sub-aquatic deposition.

Full as is this notice, we have not taken all the cream off the milk of Dr. Dawson's book. We can assure our readers there is abundant fare still left for its readers.

THE GEOLOGIST.

DECEMBER 1863.

PLANETARY ORBITS.

By the Editor.

Every day's experience confirms more and more the opinion that the central heat doctrine has less foundation than formerly it was supposed to possess. Its great supporters have gradually increased the necessary thickness of the solid crust in proportion to the internal supposed fluid core from forty to eight hundred miles at least: rather a wide difference in itself, but not perhaps so very great in respect to the absolute diameter of the earth, to which such a relationship would be about in proportion to the thickness of a sheet of cartridge-paper round a 12-inch globe. We know nothing, however, so perfectly a non-conductor that so thin would resist the heat of the internal molten mass. Moreover, upon the alleged increase of temperature with depth in coal and other mines, much doubt has been thrown by the subsequently ascertained facts that in many instances the higher temperatures have disappeared after the mines had ceased to be worked. The necessity, if the interior were fluid, for internal tides below the supposed solid crust, also militates against the existence of a fluid core, because we can detect no such tides at the surface of our earth; and if they existed, it is difficult to conceive the rigidity and strength of so thin a crust to be equal to restraining them entirely; and if the crust were in the least degree yielding or elastic, we must have evidence of such tides in the heavings of the surface. Besides this, with a shifting axis of rotation, as our earth undoubtedly has, and for other reasons, there must be a motion of the external hardened crust different from that of the internal fluid mass, and this motion must go on, if the present views of mathematicians, astronomers, and internal-heat geologists are right, without any friction. Now, if the earth's crust is the effect of a cooling-down process from a molten condition, there must be a gradual hardening still going on; and with such a gradual hardening, there must be a portion intermediate between the solid crust and the fluid core, which must be in every possible degree of viscosity from next to hard to next to fluid; and if there be any difference of motion between the external crust and the internal core, such an intermediate viscous portion must be a source of much friction, it being absolutely in the very zone where friction would be manifested. There is no manner of doubt whatever that the internal-heat doctrine was invented to account for the supposed former higher temperature of our planet,—a point also not yet proven. Still, we are not adverse to the idea of former *differences* of temperature; but will they be found, when facts and experience have determined more exactly the grander truths, repeatedly variable, or permanently in one direction or the other?

One subject has never, as far as we know, been contemplated by either geologists or astronomers. We are taught at school to believe, and it is generally asserted in society, that the orbits of our earth and the other planets are nearly circular, or at most but slightly elliptical; and these ellipses are supposed to work round periodically, and thus to right themselves. We are taught, too, to believe in the fixity and permanence of the planetary and sidereal systems, and that the great Creator has laid the foundations of the world so sure that they can never be moved. Now, on the contrary, we sincerely believe that all creation, throughout all space, is in as active a state of change as the world we inhabit, upon which no day brings forth its similitude, and no one night is like another. If the sun be a burning body, whatever it consumes must be dissipated as vapour, or solidified as incombustible matter upon its surface. If the sun be dissipating its mass, it is lessening in bulk, and its attraction upon the earth must be lessened. If the sun be adding any residue of combustion to its mass, then the attraction of the sun upon the earth increases. If the attraction diminished, the earth would recede from the sun; if the attraction increased, the earth would be drawn nearer towards it, unless the velocity of the earth in its orbit increased or diminished, so as to make a compensation.

Now, as the earth possesses no apparatus for, or power of producing its own onward motion, we have no alternative but to consider the orbital motion of the earth as due to an initial velocity imparted to it originally at some vastly distant period of time. But if we regard the earth's motion as originally initial, it becomes at once certain that if the earth in its orbit pass through the ether or matter with which the circumambient space around us is filled, that there must be —no matter how fine, how attenuated that ether may be—*friction;* and friction, however slight, effects retardation. Moreover, the moon retards the earth: as Dr. Tyndall has well expressed it, "she skids the earth." Now, if there be a gradual retardation of the earth in her orbit, there is a gradual diminishing of the centrifugal velocity which counteracts the sun's attraction; and if the centrifugal compensation diminish, the earth must gradually be approaching the sun; for the earth's orbit, if originally circular or elliptic, *must* assume a *spiral* condition directly there is any alteration of the great counterbalance of the sun's attraction by centrifugal force, whether that alteration be increased or diminished attraction, or increased or diminished velocity of revolution; for with an inward tendency towards the sun the spiral would be a gradually approaching one, and with outward tendency to fly off into space, a gradually extending one. Nor would this spiral orbit produce any effect on the sidereal day or year, for the loss of velocity in the earth would be counteracted exactly by the inward contraction of the spiral and the consequent shorter distance to run. Again, if the earth's orbital motion be due to an initial velocity *imparted* in the remote past, the earth's orbit must still be a spiral one, because, if initial and imparted, the original velocity had the nature of *projectile* force, and the tendency of the original motion must have been in a *direct* or *straight* line until the earth came *within range* of the sun's attraction; and this attraction diminishing, as a perfect sphere enveloping the central attracting globe or sun, must have been, as far as its influence was exerted upon the projected world, a circular influence, from which the earth could not extricate itself, and the resulting figure of the combination of a straight line and a circle must necessarily be a *spiral.*

For very many years I have held this idea of *spiral planetary orbits*, and the recent letter of Mr. Hind, the astronomer, on the possibility of the variation of our earth's distance from the sun, seems to give support to such a conclusion. Certainly a *spiral orbit*, capable of extension or compression, would give play to the earth's distance from the sun, and render intelligible former variations of temperature of our planet. We have before, in this volume, thrown out speculations on possible cosmical occurrences and conditions, and we wish the idea now offered for discussion to be regarded as no more, at present, than a speculation.

ON THE OCCURRENCE OF *WALDHEIMIA (TEREBRATULA) TAMARINDUS*, AND THE DISTRIBUTION OF BRACHIOPODA, IN THE CRETACEOUS ROCKS OF IRELAND.

By Ralph Tate, F.G.S.

E. R. Lankester, Esq., in his paper "On some Cretaceous Brachiopoda,"—see November number of 'Geologist,'—states *T. tamarindus* to be a rare shell; so also in Davidson's 'British Brachiopoda,' Pal. Soc. Publications, the localities for this species given in that monograph are:—Isle of Wight, in Lower Greensand; near Sandgate, in Kentish Rag; and Upper (?) Greensands of Faringdon. I have to add another locality—Colin Glen, near Belfast. This species occurs with us in true Upper Greensand, associated with *Ammonites peramplus*, *Pecten æquicostatus*, *Exogyra columba*, *Vermicularia concava*, etc.

I have generally found it, in masses of 2 or 3 inches in thickness, among the soft chloritic sandstones, and never in a continuous band. I have not met it in any other locality; but individuals may be obtained in abundance in the locality given.

The distribution of this species is thus extended, ranging from the Neocomian to the Upper Greensand.

I take this opportunity of furnishing a list of the Brachiopodous shells of the Cretaceous rocks of the county Antrim.

The species have nearly all been collected in the immediate neighbourhood of Belfast.

Brachiopoda of the Hard Chalk, White Limestone: Upper Chalk.—*Crania Ignabergensis*, Retz, *Rhynchonella plicatilis*, Sow., *Terebratula carnea*, Sow., *T. semiglobosa*, Sow., *T. obesa*, Sow., *T. biplicata*, var. *Dutempleana*, D'Orb., *Terebratulina striata*, Wahl.

Upper Greensand.—*Rhynchonella limbata*, Schlott, *R. latissima*, Sow., *R. compressa*, Lam., *Terebratula biplicata*, Sow., *T. semiglobosa* var. *bulla*, Sow., *Terebratulina striata*, Wahl., *Waldheimia tamarindus*, Sow.

Gault.—*Rhynchonella nuciformis*, Sow., *Terebratula squamosa*, Mant.

PLATE XXIII.

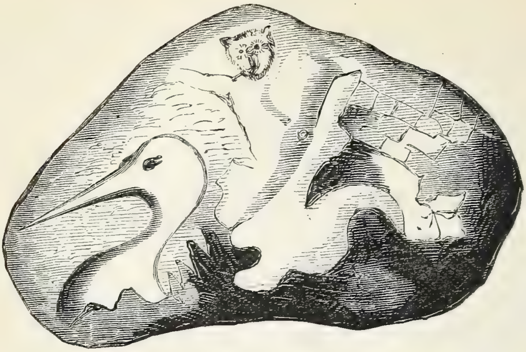

Fig. 1.

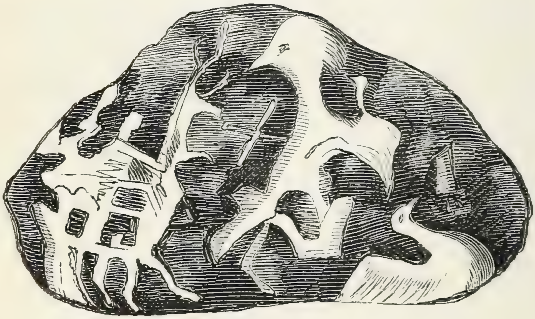

Fig. 2.

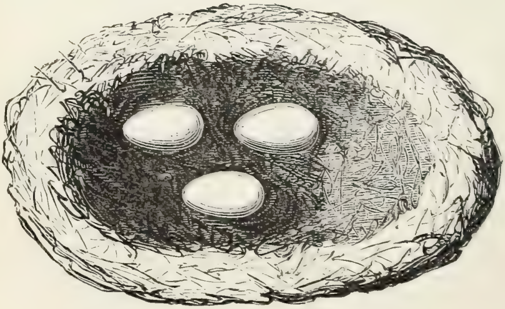

Fig. 3.

FOSSIL BIRDS.—Facsimiles from Kircher and Buttner.

FOSSIL BIRDS.

By the Editor.

(*Continued from page* 424.)

The thick folio book of Athanasius Kircher is an extraordinary one in many respects, and chiefly in respect to the numerous subjects it treats of, and the number of its woodcut illustrations. Rough as these are, they give us a better idea than mere descriptions of the objects he speaks about. Like other of these old authors, he copies a great deal from his predecessors and contemporaries; indeed one gets wearied of this eternal copying by these, for the most part, old doctor-naturalists, and of the endless cross-references from one to another. Still, for our purpose, which is to give all the literature on the subject, we must submit some few more extracts from old books.

The title of Kircher's book is 'Mundi Subterranei,'[*] and the first reference we meet with is, in Tom. ii. lib. viii. de Lapidibus, sect. 1, cap. ix. p. 34, fig. "avium in lapidibus expressio,"—of birds expressed on stone. (See Vol. VII. Pl. II. Fig. 6.)

We next come to numerous figures of other "flying creatures" at p. 35, etc. Tab. I. is headed, "Figuræ Volucrum, quas Natura in lapidibus depinxit, ex variis Museis decerptæ et aliunde transmissæ."

"Figures of winged creatures, painted by nature on stones, taken from various museums, and otherwise transmitted."

Then follows the descriptive translation below:—

"The first figure represents a head of a Stork, together with some, but I do not know what, quadruped. At the top is something like a human face. Extracted from Aldobrandino"[†] (see Pl. XXIII. Fig. 1). "2. Shows various forms and parts of animals, winged creatures as well as quadrupeds, although very imperfect, the cause of which we give in the physical examinations" (see Pl. XXIII. Fig. 2). "3. Represents the figures of two birds expressed by nature on marble in the church of St. George's, at Venice, referred to by Ambrosinus" (see Vol. VII. Pl. II. Figs. 3, 4). "4. Shows the head of an Owl, surrounded by rudiments of other birds" (see Pl. XXIV. Fig. 2). "5. Represents the figure of a Wagtail, or as others prefer, of a Peacock" (Pl. XXIV. Fig. 3). "6. Shows the figure of a monstrous bird" (Vol. VII. Pl. II. Fig. 4). "7. The figure of a Merle" (Vol. VII. Pl. II. Fig. 5).

"Prima Figura notat *Ciconiæ caput*, et annexum ei nescio quid animalis quadrupedis. In summitate *humanæ faciei* quid simile: Ex Aldobrandino extractum. 2. Monstrat varias rerum formas partesque animalium, tam volucrium quam quadrupedum, quamvis valde imperfectas, quarum rationem dedimus in disquisitione physica. 3. Duarum avium imagines monstrat, quas in Ecclesia S. Georgii Venetiis in marmore a natura expressas refert Ambrosinus. 4. Noctuæ caput demonstrat, circumdatum aliis avium rudimentis. 5. Motacillæ, sive, ut alii volunt, Pavonis figuram exprimit. 6. Monstrificæ volucris figuram docet. 7. Merulæ figuram exprimit."

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[*] "Athanasii Kircheri e Soc. Jesu Mundi Subterranei Tomus IIus, in V. Libros digestus, quibus Mundi subterranei fructus exponuntur, et quidquid tandem rarum, insolitum et portentosum in fœcundo Naturæ utero continetur, ante oculos ponitur curiosi Lectoris.

"Ὁς νάεις κατὰ πάντα μέρει κόσμοιο γενάρχα
Ὁς δαπανᾶς μεν ἅπαντα, καὶ αὔξεις ἔμπαλιν αὐτούς.

"Omnes qui partes habitas, mundique Genarcha,
Absumis qui cuncta eadem, qui rursus adauges.

"Amstelodami, Ex Officina Janssonio-Waesbergiana, anno 1678."—Orpheus.

[†] The inscription under the fig. 1 (*Ciconiæ et Noctuæ figuræ*) does not correspond with this explanation.

It is necessary to add in this place the inscriptions inserted in Kircher's plate under the figures, and for convenience' sake we give the references to his own instead of our plate.

Fig. 1. Ciconiæ et Noctuæ figuræ. Fig. 2. Confusæ rerum variarum formæ. Fig. 3. Venetiis in templo S. Georgii. Fig. 4. Caput Noctuæ. Fig. 5. Figura Motacillæ. Fig. 6. Animalis jubati.

In Ritter we find a cross-reference to Seyfrid's 'Medulla Mirabilium Naturæ,' p. 437; but on turning to the work,* we find in the subjects treated there nothing relating to birds. The passage at p. 437 runs, roughly translated, thus:—

"In America, about Chili, there is on a mountain plenty of precious stones. In a cavern, the image of the Most Holy Virgin, with her baby in her arms; admired by all spectators."

Turning over to p. 438, we read that at "half a mile from the convent Michelfield is a quarry, where stones forming round plates, and bowls, are so perfectly manufactured by nature, that the people never want any china or earthen vessels for domestic purposes."

In glancing over the pages, however, we come upon a passage at page 458, of which the following is a translation:—"Even in France, at Limans, a village or Provence about a league distant from Forcalquier, a city of good note, there hath been sometime found, in a certain mine of a kind of reddish soft stone, a great number of these *Gamahes*, or painted figures, of birds, mice, trees, serpents, and letters, so exactly shaped that little children could tell what they were.—*Gaffarellus*."

The work of Gaffarell, from which this extract is made by Seyfrid, bears the title of—"Cvriositez inovyes svr la Scvlptvre Talismaniqve des Persans. Horoscope des Patriarches, et Lectvre des Estoilles," and was published in 1637.† There was an English translation by Edmund Chilmead, Master of Arts, and Chaplaine of Christ Church, Oxon, printed at London in 1650. The passage in which, at p. 104, is given above as the translation.

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* "Medulla Mirabilium Naturæ. Das ist: Auserlesene, unter den Wundern der Natur, aller verwünderlichste Wunder, von Erschaffung der Natur, Himmlischen Firmaments, Sternen, Planeten, und Cometen; als auch dieser sichtbaren Welt, und des Meers. Dessgleichen, in Brunnen, Flüssen, Seen, und dem Meer; Auf, An, und in Gebürgen, Erden, und Insulen; Wie auch, etzlichen Thieren, Bäumen, Früchten und Gewächsen. In Europa, Asia, Africa und America. Aus hiernächst benandten Autoren zusammen getragen und beschrieben; sammt beygefügten Kupffern. Durch Johann Heinrich SEYFRID, Marco Brettano Francum; Hoch-Fürstl. Durchl. zu Pfaltz-Sultzbach Hof-Bedienten. Sultzbach. In Verlegung Johann Hofmanns, Kunst- und Buch-Händlers in Nürnberg. Druckts Abraham Lichtenthaler, 1679."

† The extract is from page 78 of the French, and page 104 of the English edition.

Johannes Christianus Kundmann, a doctor of Wratislaw, in his 'Promptuarium Rerum Naturalium et Artificialium Vratislaviense,' published in 1726, says (p. 67) that a petrified egg was discovered at Wizin, in Bohemia, and that "a petrified foot of a big *Paviran*, with all its five nails, was discovered in Silesia,"—adding, "this is a very curious specimen, the like of which is not to be found in any museum, and the more curious as it shows even the blood converted into stone."

What a "paviran" is, we confess to be ignorant. *Pavara* is an Italian name for the domestic duck; but the "five nails," which the fossil referred to by our author possesses, renders more than doubtful any association with the foot of the *Anas anser*.

The passage in the original German is:—

> "Ein zu Stein gewordenes Ey, welches zu Wizin in Böhmen gefunden; ein zu Stein gewordener Fuss mit allen 5 nägeln von einem grossen Paviran, welcher in Schlesien gefunden worden (dieses ist ein curiöses Stück, welches man in keinem Cabinet finden wird, weil auch so gahr man das Blut oben noch siehet, das zu Steine worden)."—P. 67.

Further on in this work, we find in his Catalogue of "Marmora, Stalactitæ, Lapides speculares, calcarii, tophacei, arenæ," etc., the record of "an egg entirely incrusted with tufa:"—

> "110. Topho Ovum totum ibidem incrustatum (s. 513). Tophum hunc descr. *Gothfr. Berger*, 'de Thermis Carolinis,' p. 14–20. Alios vero descr. in *Georg. Agricola* de Nat. Fossil. lib. vii. cap. xii. p. 640. *Ans. Boetius* in Hist. Gem. et Lapid. lib. ii. cap. ccxix. p. 402. *Joh. de Laet* de Gem. et Lapid. lib. ii. cap. xii. p. 132. Prc. *Ul. Aldrovandus* in Mus. Metallic. lib. iv. p. 703. *Ol. Wormius* in Museo, lib. i. cap. vi. p. 51. *Boh. Balbinus*. Miscell. Hist. Reg. Bohem. lib. i. cap. xxiv. p. 63; it. *Rob. Ploot*, Nat. Hist. of Oxfordshire, p. 34, et ex eo *Joh. Jac. Scheuchzerus*, Hydrographiæ Helvetiæ (quæ est Hist. Natur. Helveticæ, part ii. p. 320), cons. *Carol. Nic. Langii*, Hist. Lap. fig. Helv. part ii. lib. iii. cap. ii. p. 55."

Still further on, in his Catalogue of "parts of other petrified animals," we have the following entry at page 254:—

> "17. Oscicula petrefacta avicularum alba accuratissima ex monte Hassiæ, vulgo 'dem Vogels-Berge,' eruta (s. 314).
>
> "18. Oscicula talia petrefacta lævia Maslensis coloris nigricantis (s. 322)."
>
> Vid. *Leonh. Dav. Hermann*, Maslographia, part ii. cap. ix. page 224. Varias Opiniones collegit *Dav. Sigm. Büttnerus* in Rud. Diluvian. page 304.

There are several reprints of Zannichelli's catalogue of the fossils in his museum. The one usually quoted from is the "ENUMERATIO RERUM NATURALIUM QUÆ IN MUSÆO ZANNICHELLIANO ASSERVANTUR," published at Venice in 1736, in which he notes "a hen's egg discovered in a very hard stone" by the following entry:—

> "Musæi Zannichelliani abacus alter, in quo fossilia figurata continentur."
> 206. Ovum gallinaceum in saxo durissimo inventum ex Agro Romano."

We find the record, however, ten years earlier, in his "EX NATURÆ

GAZOPHYLACIO PENES JOANNEM HIERONYMUM ZANNICHELLI VENETIIS. Index Primus quo Fossilia figura recensentur.—Venetiis, 1726."

"206. Ovum gallinaceum in saxo durissimo inventum ex Agro Romano."

The next work we meet with is the 'Magnalia Dei' by Bruckmann[*] (1730). Two figures, which he engraves, are the same as Hermann's in our Plate XXII. Fig. 3, and Wolfart's in our Plate XXIII. Fig. 3. A third figure of Bruckmann seems to be an engraved seal. His reference runs thus:—

"DIETZ, eine Graffschafft, hat Eisen-Gruben und schönen Marmor, und schreibt Petrus Wolfart in seinem Vale Hanoviæ et Salve Cassellæ dicto, etc., von diesem Marmor zu Dietz, p. 24, also: *Minime vero Marmoribus,*" etc. etc.—Bruckmann, 'Magnalia Dei in Locis Subterraneis,' ii. p. 107. [DIETZ, a county, has iron-mines and beautiful marble; Petrus Wolfart, in his 'Vale Hanoviæ et Salve Cassellæ,' etc., in speaking about the marble of Dietz, says, p. 24: *Minime vero Marmoribus,*" etc. etc.]

Retzius, 'Historia Naturalis Dendritæ Lapidumque Cognatorum,' 1734,[†] is the next work we quote from. He says:—

"To conclude, we present here a list of the dendritic and other similar stones conserved in our stone-collection of Lund, and which can throw some additional light on our work; the following are the most interesting among them:—20 (p. 109). A flint stone or a common pyrites, representing a figure of a small *bird,* perhaps the Geranites of Pliny, Croppensis, plate iii. fig. 5."

(See our Plate XXIV. Fig. 7.)

The original passage runs:—

"§ XIII. Coronidis loco subnectam jam indicem eorum dendritatum cognatorumque lapidum in lithophylacio nostro Lundensi asservatorum, qui huic nostræ lucubrationi aliquam lucem fœnerare posse videntur; sunt autem eorundem specimina quæ sequuntur, præcipua.

"20 (p. 109). Silex seu pyromachus vulgaris aviculæ figura insignitus, forte Geranites Plinii, Croppensis, tab. iii. fig. 5."

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[*] "Magnalia Dei in Locis Subterraneis, oder Unterirdischer Schatz-Kammer aller Königreiche und Länder, IIter Theil, in ausführlicher Beschreibung aller, mehr als MDC Bergwercke durch alle vier Welt-Theile, welche von Entdeckung derselben bis auf gegenwärtige Zeit gebauet worden, und noch gebauet werden; in was Stande sie jemals gewesen, und wie sie itzo beschaffen; was für Ertze, Steine und Berg-Arten aus solchen jemals gewonnen, und noch zu Tage ausgefördert werden; nebst Anmerckung aller derjenigen Länder und Oerter, wo Edelgesteine zu finden. In Geographischer Ordnung vielen Kupffer-Figuren und Alphabetischen Register, zu besichtigen dargestellt von Francisco Ernesto BRUCKMANN, Med. Doct. Acad. Cæsar. Nat. Curios. et Soc. Reg. Pruss. Scient. Colleg. et Pract. Wolffenbutt. Wolffenbüttel. MDCCXXX."

[†] "Historia Naturalis Dendritæ Lapidumque Cognatorum quam amplissimo Philosophorum ordine in Alma Carolina veniam indulgente, Præside V. CL. DN. Doct. Kilian Stobæo, Archiatro Regio Histor. P. P. et O. Facult. Philosoph. h. a. Decano spectabili, nec non Soc. Reg. Lit. et Scient. Upsali Sodali meritissimo, dignissimo, Præceptore, ut Fidelissimo. Ita omni Reverentia Cultuque ad cineres suspiciendo pro Laurea Philosophica Naturæ Curiosorum Benevolæ Disquisitioni Modeste submittit Nicolaus REIZIUS, Med. Stud. Loco horisq. solitis ad d. 27 Maji anni M.DCC.XXXIV. Londini Gothorum, Typis Ludovici Decreaux."

Hen. Jac. Sivers, in his 'Curiosa Mendorpiensia,' Lubeck, 1734, p. 107,* catalogues the head of a goose in hard flint,—no doubt, as he expresses it, "an elegant lusus naturæ." The entry is—

"7. Lapis, caput anserinum ab utroque latere accurate repræsentans, e durissimo silice elegans naturæ lusus."

Another book of this class and similar date is Lesser's 'Lithotheologie,'† published in 1735. What we learn from him is that—

"The late Mr. CUNO, the distinguished musician and organist at our metropolitan church, discovered once, in the neighbourhood of Heringen, a flint stone, and in breaking it he found on both sides the head, together with the neck, of a *Calcutta cock*. It is of a reddish-yellow colour, the eye can very distinctly be perceived, as well as the comb bending over the beak. I conserve this stone in my museum, and can show it to any one." (Fig. iii.)

(See Vol. VII. Plate II. Figs. 7, 8, *nobis.*)

The original is :—

"Der seelige vortreffliche Virtuose und Organiste an hiesiger Haupt-Kirche, Herr CUNO, hat ehemahls bei Heringen einen Feuerstein gefunden, und zerstuffet, in welchem auf beiden Seiten der Kopf mit dem Halse von einem Calcutischen Hahn zu sehen. Er ist gelb-röthlich, das Auge distinguirt sich darauf ganz deutlich, und die über dem Schnabel hängende Nase gleichfalls. Welchen Stein ich in meinem Cabinet jedem zeigen kann."

He also refers, at page 406, to Bruckmann :—

"Dr. Bruckmann recollects a marble on which the head of an *owl* is represented."‡

In 1736, Albert Ritter published a book § on dendritic resemblances which he illustrated with figures of the specimens. In his list of curiosities of this class he enters, page 20 :—

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* Brit. Mus. 436. a. 36. The title-page reads :—" Q. F. F. Q. S. HENRICI JACOBI SIVERS Lubecensis, Philosophiæ Magistri et Regiæ Borussicæ Scientiarum Societatis Collegæ, Curiosorum Niendorpiensium, Specimen sextum et ultimum, sistens Conchitarum aliorumque Lapidum miscellaneorum descriptionem, cum viro excellentissimo atque experientissimo Domino Joachimo Theodoro Hornhard D. Serenissimi Ducis Mecklenburgici Archiatro et Consiliario Aulico communicatum. Lubecæ apud Petrum Boeckmannum, 1734."

† "Friedrich Christian LESSERS, der Kirchen am Frauenberge in der Kayserl. freyen Reichs-Stadt Nordhausen Pastoris, und des Waysen-Hauses daselbst Administratoris, LITHOTHEOLOGIE, das ist : Natürliche Historie und geistliche Betrachtung derer Steine, also abgefasst, dass daraus die Almacht, Weissheit, Güte und Gerechtigkeit des grossen Schöpffers gezeuget wird, anbey viel Sprüche der Heiligen Schrift erkläret, und die Menschen allesamt zur Bewunderung, Lobe und Dienste des grossen Gottes ermuntert werden. Zum Druck befördert und mit einer Vorrede begleitet von Johann Alberto Fabricio, Doct. und Prof. Publ. des Gymnasii zu Hamburg. Hamburg, bey Christian Wilhelm Brandt. 1735."

‡ "§ 295. Herr Dr. BRUCKMANN gedencket eines Marmors, auf welchem ein Eulen-Kopf sich praesentirt."

§ The title runs :—"Alberti Ritter Gymnasii Ilfeldensis Regii Con-rectoris Commentatio II. de Zoolitho-Dendroidis in Genere et in Specie de Schvvartzburgico-sondershvsanis curiosissimis ac formosissimis, una cum Supplemento Rerum Naturalium et Curiosarum hujus Regionis in Lucubratiuncula II. de Alabastris Schvvartzburgicis quondam a me Delineatarum jam denuo Recognitarum et Auctarum, Typis Exscripta cum Figuris Æneis. Sondershusæ, 1736."

"*Pavo* lapidi a natura inscriptus; Plinius, part i. p. 13.

"*Gallus* in marmore; Kircher, Mund. Subter. tom. ii. p 39.

"*Gallina* in rene lapidis fissilis Ilmenauiensis; Mylius, loc. cit. part i. p. 47; item part ii. p. 73, fig. n. 1.

"*Aves* in fissili lapide Bottendorffiensi; Mylius, loc. cit. part i. p. 13. Aves et flores varii generis in marmore Eichstadiensi; vide Seyfried, 'Medullam Mirabilium Naturæ,' p. 437.

"*Aviculæ* figuræ silex, sive pyromachus vulgaris Croppensis insignitus forsan Geranites Plinii est; Excellent. Stobæus in Hist. Natur. de Dendritis, p. 34, n. 20, t. ii. fig. 5.

"*Caput ululæ* in marmore Dietzensi; celeberr. D. Bruckm. Magn. Dei, part ii. p. 107, t. 27, fig. 2.

"*Caput gallopavi* cum parte colli in pyrita; venerand. Lesser, in Lithotheol. p. 406, fig. n. 1. et 2."

Bruckmann (1749), in his 'Epistolarum Itinerarium,'* copies Ritter's (see *ante*, page 449) plates and descriptions of the dendritic stones, the bird-figures on which are given in our Pl. XXIII. and Pl. IV. in Vol. VII. The descriptions are printed above.

Tab. XXII. p. 343. "Porro ex ejusdem Comment. II. de Zoolithis-Dendroidis offero: Fig. 1. Lapidem quadratum, coloris lucido-cæsii, exhibentem arbusculas et fruticeta coloris nigerrimi, intermixtis nonnullis ramulis coloris punicei."

At another part of his work he describes two dendritic stones, of which he gives elaborate copper-plate engravings. One is figured in our Pl. XXIII. Fig. 3, and the other part of an extensive landscape, in which there is a pig as big as a house or a house as small as a pig, whichever the reader or spectator like, and flying away from a row of bushes, what Ritter describes, as "a *bird*, with a long tail, the head adorned with long and erected feathers, the wings displayed, flying through the *air*, expressed distinctly by nature;" but which looks as much like an insect as a bird, and really, to our eyes, has as little resemblance to one as the other. We give a facsimile (Pl. XXIV. Fig. 1) of this object, as evidence of the imaginative faculties of a naturalist a hundred and fifty years ago; and add also the original passage describing the specimens.

"Numer. III. Lapis habet figuram geometricam nempe trapezoidalem, longus est ipsum pedem, latus tres pollices, crassus semipollicem; segmentum hoc est lapidis, qui crassitudine ipsam excedebat palmam; ambo latera sunt optime lævigata et polita. etiam subtili et perlucente vernice obducta, hinc multo elegantius et vividius sistuntur omnia; naturali magnitudine hunc, et jam descriptos lapides æri cælari curavimus, fruticeta, arbusculæ, imagines reliquæ elegantissime et plenissime sunt expressæ, nigerrimi coloris; sed quod nomen huic lapidi inponamus, ipsi hæsitamus, forsan cum B. Baiero illum nominare possimus *archipelagitem*, cujus quidem descriptioni non absimilis,† concedet tamen benevolus lector et spectator

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* "Francisci Ernesti BRUCKMANNI Phil. et Med. Doct. Acad. Cæsar. Leopoldino-Carolinæ Nat. Cur. ut. et Societ. Regio-Prussicæ Scientiarum Membri, juxta ac Assessoris Colleg. Medici Illustr. Brunsvic. et Poliatri Wolffenbüttelensis. Centuria Secunda Epistolarum Itincrarum accedit Museum Closterianum. Wolffenbüttelæ, MDCCXLIX."

† In Sciagraphia Musei sui et Supplementis Oryctogr. Noricæ, p. 49.

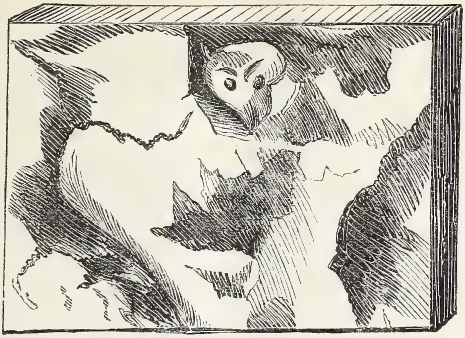

Fig. 1.

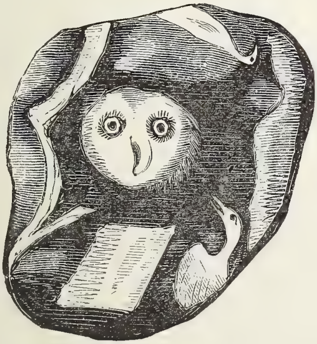

Fig. 2.

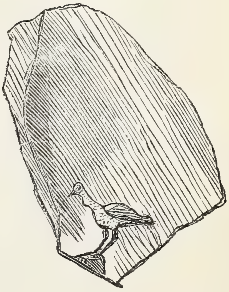

Fig. 4.

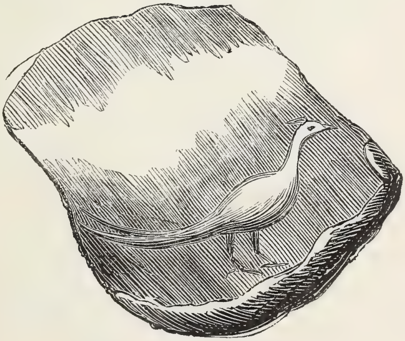

Fig. 3.

FOSSIL BIRDS.—Facsimiles from Wolfart, Kircher, Retzius, and Ritter.

curiosus, nobis imaginari, lapidem repræsentare quoddam stagnum, margines cujus circumcirca fructicetis sunt obsessæ, in hoc adparere insulas majores, minores, minimas, easque fruticetis mollibus obductas, et quod imprimis admiratione dignum, simul in illis videri ædem parvam cum fumario, non procul hinc animal quoddam quadrupes, cui spectatores nomen ursi indiderunt, quipp cujus non dissimilis, adhuc *avem* cauda longiore, in capite pennis longioribus et erectis ornatam, expansis alis per auras volantem, exactissime a natura ludente expressa quæque; et quia notatæ figuræ ipsum penetrant lapidem, in altero latere similiter indicata adparent, hac solummodo variatione, ut dicta animalcula desiderentur, etiam hic vel illic novus quasi efflorescat ramulus arboreus, imprimis, si lapis fissuras parvas acceperit. Quando nunc secundum proverbium: *Deus et natura nihil faciunt frustra*, æquum erit, hæc miracula adspicientes Deum mirabilem, inque operibus suis inperscrutabilem debite mirari, atque decentibus laudibus extollere, namque testante Psalmista: *Opera Jehovæ magna, exposita omnibus qui delectantur illis, gloriosum et decorum opus ejus.*"

The following is Ritter's account of fig. ii. (see Pl. XXIII. Fig. 3, *nobis*), referred to in the above quotation:—

"Fig. II. An oblong squared stone, polished, exhibiting very singular pictures; a whole region, hills covered with very small shrubs, mountains slightly rising, broken stones and rocks, grass, and even reeds, a rustic cottage ornamented at its ridge with green boughs of a tree, a strange *bird*, not unlike the ostrich, black clouds as if disposed for throwing flashes," etc.

The original we give below:—

"Fig. II. Lapidem quadratum oblongum, politum, offerentem picturas plane singulares, integram regionem, colles subtilissimis fruticetis ornatos, montes parvos acclives, rupes ac saxa prærupta, cum gramine nec non arundine, casam rusticam fronde quasi viridi in culmine ornatam, *avem* peregrinam, struthioni non absimilem, nubem nigriorem, quasi fulgora emittentem," etc.

We quote now from 'L'Histoire Naturelle, éclaircie dans une de ses parties principales, l'ORYCTOLOGIE, qui traite des Terres, des Pierres, des Métaux, des Minéraux et des autres Fossiles, enrichi des Figures dessinées d'après Nature.' By M. ⁂ (Ant. Jos. Dezallier d'Argentville) des Sociétés Royales des Sciences de Londres et de Montpelier.—Paris, 1755.

Under the heading BIRDS, M. Argentville says:—"It is quite certain that birds, owing to the faculty they possess of flying, can more easily escape immersion than any other animal; and this is the reason of the scarcity of petrified birds, and why we only find their débris, such as their feathers, nests, and eggs. The feathers and the tail of a bird found on a stone at Oeninghen (Scheuchzer), a beak of a petrified bird, on a black stone, in the same country (Mus. Zannichelli); a petrified cuckoo, commonly called *Pesce capone;* eggs, birds' nests enclosed in stone; feathers and petrified nails, exhibited by the limestones of the parish of Karabglony, in the province of Westrogothland, in Sweden (Bruckmann). *Ornitholitus nidorum Linariæ:* a stone containing a nest of a petrified Linnet, incrusted with salt of tartar, from Artern. *Tubulites* full of small worms, found in the island of Gothland. *Gallina cum ipsis ovis incubans,* a hen hatching her eggs, found petrified in a salt-pit of Transylvania (*De Thermis* And. Baccii)."

The following is the original in the French :—

> "Oiseaux.—Il est certain que les oiseaux, par la facilité qu'ils ont de voler, se sauvent plus facilement de l'immersion que les autres animaux ; c'est ce qui fait la rareté des oiseaux pétrifiés, et qu'on n'en trouve que les débris, tels que des plumes, des nids, des œufs. La plume et la queue d'un oiseau, trouvées sur une pierre d' Œninghen (Scheuchzer).
>
> "Un bec d'oiseau pétrifié, sur une pierre noire du même pays (Mus. Zanichelli).
>
> "Un coucou pétrifié, appelé communément *Pesce capone.*
>
> "Des œufs, des nids d'oiseaux, enclavés dans la pierre.
>
> "Des plumes et des ongles pétrifiés, que montrent des pierres calcaires, de la paroisse de Karabglony, province de Westrogothland, en Suède (Bruckmannus).
>
> "*Ornitholithus nidorum Linariæ,* pierre contenant un nid de Linote pétrifié, incrusté de sel de tartre, venant d'Artern.
>
> "*Tubulites,* pleins des vermisseaux, trouvés dans l'Isle de Gotland.
>
> "*Gallina cum ipsis ovis incubans*, une poule couvant ses œufs, trouvée pétrifiée dans une saline de Transilvanie (*De Thermis,* And. Baccii)."

As D'Argentville refers to insect-remains in the 'Stone of Oeningen,' there is no doubt of its being the well-known limestone of that place. At page 334, after the insects from the "stones" of Frankenberg and of Wirtzburg, he adds :—

"*Ornithoglossum*, glossopetrum imitating the tongue of a pie, from Malta. (Lindius.)

"*Gracirrhynchus*, glossopetrum imitating the beak of a raven. (Lachmundus).

"A petrified nest, with its chickens, discovered near the city of Lubeck, according to Albertus Magnus, as reported by Lachmundus."

We add the original :—

> "*Ornithoglossum,* glossopètre imitant la langue d'une pie, venant de Malte. (Lindius).
>
> "*Gracirrhynchus,* glossopètre imitant le bec d'un corbeau. (Lachmundus).
>
> "Un nid pétrifié, avec ses poulets, trouvé près de la ville de Lubec, selon Albert le Grand, au rapport de Lachmundus."

Our next author is Johan Gesner, Med. D., Phys. et Math. Prof. Ord. Academiæ Imperialis Naturæ Curiosorum, et Socc. Regiar. Scientiar. Berolinensis, Sueciæ, Upsal., Gœtting., Physico-Botanicæ Florentinæ, ut et Physico-medico Basiliensis membr., in whose 'Tractatus Physicus de Petrificatis, in duas partes distinctus, quarum prior agit de Petrificatorum differentiis et eorum varia origine; altera vero de Petrificatorum variis originibus, præcipuarumque Telluris mutationum testibus (Lugduni Batavorum, 1758),'* are the following passages :—

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* We have since found these passages in an earlier work of Gesner's :—"ΣΥΝ ΘΕΩ. Dissertatio Physica de Petrefactorum differentiis et varia origine, quam, auxiliante Deo,

"Cap. XX. p. 66.—*Zoolithus avis*, or Ornitholitus, is a petrified bird, which is very seldom to be met with amongst the Petrificata.

"1. *Ornitholitus avis integræ.*—Ornitholite of a whole bird, which, according to Linnæus and Wallerius, is conserved in some museum, has never met my eye; and these stones must at all events be very scarce, as birds, owing to the use of their wings, very easily escape the dangers of waves and immersion.

"2. *Ornitholitus plumarum.*—Ornitholite of feather. Scheuchzer, in his 'Vindiciæ Piscium,' describes a specimen of such a fossil bird's feather in stone discovered at Oeningen.

"3. *Ornitholitus nidorum.*—Petrified nests. They are found sometimes in the subterranean caverns full of stalactites, and in tufas; but they may be rather classed amongst the incrustata, or incrustations, than amongst the lapidifacta, or petrifactions. Such a nest was discovered in a cave by Baumann; five others are described by Bruckmann. These incrusted nests are sometimes formed from stalactite, or earth deposited from saline water in layers within the apartment.

"Such a nest of a linnet, together with its eggs, incrusted with salt of tartar, discovered at Artern, is quoted by the said Bruckmann in his 'Museum,' and a similar one is to be seen in the museum of Ritter, tab. 44, f. 5.

"Such true incrustations, as well as others of this class, are not unfrequently encountered in salt-pits. A very curious specimen is quoted by Bacci And. in his work 'De Thermis,' lib. v. c. 4, p. 157. In some place of Transylvania, he says, there was in a salt-pit a hen discovered hatching her eggs, and which, owing to the salt with which she was covered, was preserved incorrupted, and is still to be seen."

The original Latin of the text we give below:—

"Caput XX. (p. 66.)

"*Zoolithus Avis* seu *Ornitholitus* est Petrificatum Avis. Hoc inter Petrificata maxime infrequens esse solet.

"1. *Ornitholithus avis integræ* quoad nomen exstât apud cl. Linnæum et Wallerium in museo quodam conservetur, mihi non constat. Sed non possunt non rarissimi esse hi lapides, quum Aves alarum ministerio undis et submersionis periculis se facile subducant.

"2. *Ornitholithus Plumarum.* Lapidem fissilem Œningensem, qui Avis Pennam referat, describit et depingit cel. Scheuchzerus in Vindiciis Piscium, tab. ii.

"3. *Ornitholithus Nidorum*, quandoque in Cryptis subterraneis Stalactita prægnantibus, et inter Tophos occurrit, sed inter incrustata potius quam lapidifacta referri meretur. Hujus generis nidum possideo in antro Baumannio inventum; alios quinque recenset clar. Bruckmannus.* Formantur ejusmodi nidi incrustati nonnunquam et stalactita vel

Præside Johanne Gesnero, Med. D. Phys. et Math. Prof. Ord. Academiæ Imperialis Naturæ Curiosorum, et Socc. Regiar. Berolinensis itemque Suecicæ Upsaliensis, ut et Physico-Botanicæ Florentino Membro, pro consequendo Examine Philosophico, defendent David à Moos, Casparus Ammianus, Felix Hofmeisterus, Rodolphus Dænikerus, Henricus Kilchspergerus, Joh. Luc. Salomon Wolfius. At d. 21 Mart. H. L. Q. S. Tiguri, Ex Officina Gessneriana. An. mdcclii."

* Epist. Itiner. Centur. ii. p. 25, tab. 7, 8. Wolfenb. 1749, 4.

terra, quam deponit aqua Salina in domo gradatoria (*Gradierhaus*). Talem nidum Linariæ totum una cum ovis, tartaro salino incrustatum de *Artern* allatum, recenset ex suo museo laudatus BRUCKMANNUS,[*] et similem ex Museo Ritteriano sistit tab. xliv. f. 5. *Sale* vero *incrustata* non raro hæc et alia hujus generis in salifodinis reperiuntur. Memorabile exemplum prostat apud BACCIUM[†] de Thermis, l. v. c. 4, p. 15. Quodam loco (sic scribit) in Transylvaniæ Salifodinis Gallina cum ipsis ovis incubans reperta est, quæ eo obducta sale servata est, ac incorrupta etiam nunc ostenditur."

In the 'Dictionnaire Universel des Fossiles Propres et des Fossiles Accidentales,' by M. E. Bertrand, Premier Pasteur de l'Église Françoise de Berne, Membre des Acad. de Berlin, etc., published at La Haye in 1763, ornitholites are thus described, at page 86:—"Parts of petrified birds. Ornitholite, *Avium petrificata.* In German, 'versteinerte Vögel,' or 'Vögel-knochen.' The ornitholites are very scarce. I am not sure if there has been a single entire petrified bird ever seen, however Linnæus and Wallerius speak of them. The parts of these birds, or the remains belonging to them, which are more commonly met with, are the horny parts, the beaks, bones, nails, eggs, and nests; but at all events there is always a fear that persons may be deceived by resemblances in which the fancy as well as the desire for some curiosity plays its part. See F. Gessner, de Petrificatis, cap. xx. p. 66."

The original runs:—

"Ornitholites, ou parties des oiseaux pétrifiées. Ornitholithe, Avium petrificata. En allemand: versteinerte Vögel, oder Vögel-knochen. Les ornitholites sont fort rares. Je ne sçai si on a jamais vu d'oiseau entier pétrifié, quoique Linnæus et Wallerius en parlent. Les parties de ces oiseaux, ou qui leur appartiennent, les cornes, le bec, les os, les ongles, les œufs, les nids, peuvent être plus communs. Encore est-il fort à craindre qu'on n'ait été trompé par une ressemblance, à laquelle l'imagination et le désir des choses rares aura prêté quelque chose. Voyez G. Gesner, de Petrificatis, cap. xx. p. 66. Lugd. Batav."

The next notices that we find of bird-remains are in Davilla's 'Catalogue,' a rather remarkable book. Under the head of Ornitholites, in the 'Catalogue Systématique et Raisonné des Curiosités de la Nature et de l'Art, qui composent le Cabinet de M. Davilla (Paris, 1767, vol. iii. p. 225), we read:—

"*Ornitholites.*—Ces pétrifactions sont les plus rares de toutes, à moins qu'on ne veuille y ranger les Nids d'Oiseaux, les plumes et autres parties de ces animaux, que l'on trouve incrustées par les eaux de certaines fontaines; mais ces incrustations ne sont point des Pétrifications proprement dites et appartiennent à une autre classe.

"301. Un bec d'oiseau, imprimé en relief dans un schiste, de Reutlingue. Ce bec est un peu entr'ouvert, strié en-dessus, et porte quatorze lignes de long sur cinq dans sa plus grande largeur. Plus, Os fossile, de Canstadt, orné presque en entier de très-jolies Dendrites, et que paroît être l'os de la cuisse d'une Poule."

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[*] Epist. Itiner. Centur. ii. p. 587.

[†] De Thermis Andreæ Baccii, lib. vii., ed. noviss. Patav., 1711, f.

In another chapter Davilla records the following fossils from Canstadt, therefore probably from the same beds as his Ornitholite:—molar teeth of Rhinoceros, "Une canine, blanche, à petites herborisations bleuâtres, adhérente à une portion de mâchoire pareillement herborisée;" another tooth, "Arborisée . . . son intérieur est calciné et adhère fortement à la langue;" six other teeth, "Sçavoir, deux arborisées, de Canstadt, l'une de Rhinoceros,* l'autre inconnue,† deux simplement fossiles, dont une de Cheval dans son alvéole. Plus, une portion de mâchoire aussi fossile, trouvée à Canstadt," and fifteen other bones unnamed. These memoranda would lead one to refer the Canstadt Ornitholite to the Pleistocene age.

(*To be continued.*)

CORRESPONDENCE.

On the Causes of Earthquakes.

Sir,—The occurrence of an earthquake of unusual violence in England has naturally given rise to very general inquiries and speculations on the nature and causes of these phenomena; and various theories more or less ingenious, but, for the most part, vague and obscure, have been broached upon the subject in the different organs of public instruction.

I have not, however, seen anywhere a notice of that simple, and to my mind conclusive, view of the question which I have put forward in my recent work on Volcanos, and I therefore venture to call your attention and that of your readers to it.

I there refer (p. 294) "these sensible vibratory undulations of the earth's surface to the snap and jar occasioned by a sudden and violent rupture of solid rock-masses at a greater or less depth, and probably the instantaneous injection into the fissures so formed of intumescent molten matter from beneath." I am happy to find an almost complete accordance between this view and that offered by yourself in your last number. But when you go on to suggest the sudden crystallization of vast underlying masses of mineral matter as the probable cause of such ruptures in the overlying rocks, I must part company with you. Why should we resort to imaginary hypotheses to explain that which, if nature is consistent with herself, is to be simply accounted for by well-known facts? It is certain that the greater number of *volcanic* eruptions are preceded or accompanied by *local* earthquakes, evidently caused by the splitting and rending of the rocks that form the flanks of the volcano, or the surrounding area, by the expansion and rise of intumescent lava beneath.

In these cases an actual escape of condensed vapour and molten mineral matter does generally take place. Not so, it is true, in the case of other earthquakes, which are usually (not always) felt over more extended areas, and therefore probably proceed from a focus of disturbance more deeply seated, so as not to admit of any outward discharge of erupted matter, gaseous or fluid, but which, nevertheless, are undistinguishable from the former in their *seismic* phenomena, and therefore may well be believed to have the same origin. An earthquake of this latter class I believe, with Mr. Mallet, to be an "incomplete effort to establish a volcano;" that is, the outward escape of pent-up volcanic heat.

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* Scheuchzer, Physiq. Sacrée, pl. 48, fig. 18.

† Ib., fig. 18, altera.

In many volcanic mountains we actually see the rents, the "snap and jar" of whose rupture through the solid rocks forming the mountain's side occasioned the earthquake. For instance, during the eruption of Vesuvius in 1860, a violent earthquake-shock was felt along the southern base of the mountain, and a crevice was seen to have opened through its flank behind Torre del Greco, radiating from the side of the eruptive explosions down to the sea, the coast of which was permanently elevated some two feet along a considerable distance. In some of the violent eruptions of the volcanos of Iceland, and also of the Pacific Islands, the mountain has been seen to be split across from top to bottom by such shocks.

The superficial fissures and changes of level which are often observed to accompany earthquakes not attended by outward eruptions, testify to the occurrence of some violent fractures and dislocation having taken place at some depth beneath. Here, then, we have a *vera causa*, seen and known to be at work in many instances, quite sufficient to explain the phenomena of those where the cause is not so apparent, owing probably to the deeper position of the point at which the shock originates. Is it not then, I ask, the most reasonable theory to refer the earthquake to the same primary cause as the volcanic eruption, namely, "the sudden expansion of some deeply-seated mass of mineral matter, owing to increase of temperature or diminution of pressure?" (See p. 296; Volcanos.)

If we suppose the heated matter below the crust of the earth—of the existence of which (at least throughout the great bands of volcanic and seismic disturbance) we have positive ocular proof in its frequent eruptions—to be (as of necessity it must be) exerting a continual upward pressure against the overlying rocks, and creating in them a violent tensile strain, it is certain that any diminution, however slight, in the amount of pressure *above* them—even the sudden lightening of the atmospheric pressure alone—may give occasion to the yielding of the cohesive force of the rocky crust, and its consequent snapping and jarring fracture, to which I attribute every earthquake. Thus is explained the more frequent occurrence of these phenomena at the periods of the Autumnal Equinox, and also when the moon is at the meridian of the locality affected, as shown in the tables of Mr. Perrey and Mr. Mallet to be the fact.

We know that the solid crust of the earth is, and has been from the earliest geological periods, continually undergoing oscillatory movements of elevation or depression. These must have been always accompanied by the fracture and fissuring of its rigid component rocks, at great depths no less than near the surface. Do not these movements correspond with, and amply explain, the frequent occurrence of earthquakes, which are precisely the kind of phenomena we should expect to experience from such sudden and violent snapping and rending of the rocks beneath us? I content myself with this explanation of the cause of earthquakes, and think it quite unnecessary to resort to any other, such as terrestrial electricity, magnetism, crystallization, the breaking-in of the roofs of imaginary subterranean cavities, or the condensation of vapour evolved from submarine volcanos; to which last theory Mr. Mallet, as I think, unnecessarily resorts.

I remain, Sir, your very obedient servant,

G. Poulett Scrope.

London, 20th November, 1863.

[The late date at which Mr. Scrope's letter arrived, precludes the possibility of my noticing at any length his very valuable communication. The experience of Mr. Scrope, and his indefatigable and acute observation of volcanic phenomena, over a period of many years, entitle his opinions to the most marked respect, and his excellent works on the subject have always excited my admiration. His views, to which he recalls my attention, had escaped me at the time of writing my article in the November number; but I made no reference to any authors or any published views, because I simply wished to put forward what I only regarded as a speculative idea, whether the crystallization of vast rocks could give rise, by their expansion or contraction, to the rupture of rock-strata not necessarily in immediate contiguity with the crystalline mass, but held in a state of tension by the difference in volume produced by crystallization. Mr. Scrope has misunderstood me altogether in supposing I meant a *sudden crystallization:* what I meant was, that the "*snap*" of the rock-strata, held in tension by the increased or diminished volume of the crystalline mass, was *sudden*. The crystallization of rock-masses I believe to be very slow, perhaps often occupying enormous periods of time to effect over great masses. Still, however slow the alteration of volume takes place, a tensile strain must be continuously accumulating until it exceeds the adhesive force of the strata, and then a "snap" occurs. I also referred in my remarks only to such earthquakes as occur without visible or evident association with active or eruptive volcanic phenomena; such, for example, as the late English earthquake, or those so constantly taking place in the neighbourhood of Comrie, in Scotland. It seems to me that there are two classes of earthquakes, one connected with volcanic phenomena, as stated by Mr. Scrope, the other, simply "snaps and jars," without any connection with volcanic phenomena at all, and produced by the crystallization, the drying and contracting, or increase of volume by heat or other suchlike natural causes which are not dependent on subterranean volcanic materials, such as molten lava or the supposed incandescent internal fluid core of our earth. I put forth the idea of crystallization as one of the possible causes of what I supposed to be non-volcanic earthquakes, with some timidity, knowing and appreciating the labours of Mr. Scrope and Mr. Mallet, and the more so that I had had little time to devote to the due consideration even of my own idea. I thought it one, however, worth promulgating, and I am gratified to read the terms in which Mr. Scrope speaks of it. —Ed. Geol.]

Mammalian Remains from Grays Thurrock.

Sir,—With a view to the settlement of some undecided points connected with the "mammalian fauna" of the pre-glacial deposit, and of the post-glacial high and low level gravels, etc., any geologists or palæontologists possessing collections from Grays Thurrock, or any of the other fossiliferous localities in the valley of the Thames, or corresponding river-valleys in the south-east of England, will greatly oblige the undersigned, by communicating to him whether they possess good specimens, containing teeth, of bears, or of hyænas; and if so, what amount of evidence the specimens present.

H. Falconer.

21, *Park Crescent, Portland Place, Nov.* 12, 1863.

Mammoth Remains at Leicester.

Dear Sir,—As it is of importance in these "drift-searching" days that all remains found of mammals in the drift should be made known to your readers, I have much pleasure in communicating to you that information was this morning brought me of a horn or tusk, of very large dimensions, had been laid open in a cutting for drainage in the valley of the Soar, in the outskirts of Leicester, and near the village of Belgrave. I at once proceeded to the President of our Philosophical Society, and obtained his permission to secure it for our town museum; and also to inform one of our leading geologists, James Plant, Esq., of the fact. We drove to the spot, and found our anticipations more than realized; for it turned out to be the tusk of a "great Mammoth," such as is very rarely found in this country.

The specimen is in a fine state of preservation, and measures 2 feet in circumference, and 9 feet in length. It lay at the bottom of a very old drift-gravel, and on the true bed of the Keuper marl, at a depth of 11 feet from the surface.

It is very interesting to find Mammoth bones on the virgin-surface of an old formation, as it establishes to my mind, beyond a doubt, the existence of the Mammoth before the "drift."

Some have doubted whether the Mammoth really was an inhabitant of this country; but this has been long set at rest; and here is undoubted evidence of the fact of its local existence. The specimen is very little water-worn.

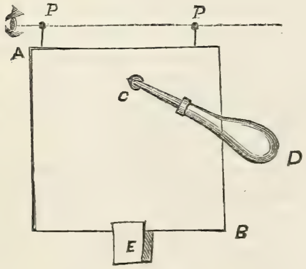
I do not know that any further remarks are necessary. The specimen in the course of this day will be lodged in the Leicester museum.

I am, dear Sir, yours very truly,
Francis Drake, F.G.S.

30, *Market St., Leicester, 27th Oct.,* 1863.

Geological Section Making.

Sir,—Perhaps you may think it worth while to mention in your journal a very simple contrivance which I devised for the purpose of laying down the contour of a piece of ground, of which I desired to make a geological section. From its extreme simplicity, combined with very tolerable efficiency, I think it would often be found useful where mathematical exactness is not required.

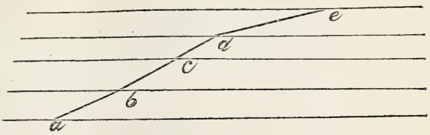


A B is a square piece of board,—accuracy of form is immaterial. It may be of any size, say six inches square. *E* is a piece of lead, bent so as to embrace the lower edge, and capable of being made to slide tightly along it. *D* is an awl passing loosely through a hole at *C*. *P P* are two common pins, stuck into the upper edge of the board.

To adjust this instrument, it is only necessary to slide the weight *E* along the edge of the board, until the heads of the two pins rest in a horizontal line, when it is suspended by the handle *D*. This may be done either by fixing a mark at the level of the eye, and looking at it from a little distance along the line *P P*, taking care that the feet are on the same level as when fixing the mark, which may be ensured by standing on the shore of a pond or the sea; or else the adjustment may be effected by sliding the weight until the *same* point of a distant object is seen along the line *P P*, when the two pins are interchanged by bringing first one and then the other next the eye.

The proper position of the weight having been determined, the instrument is ready for use.

Suppose the contour of a hill desired. Take your stand at the lowest point at which the section is required to commence; hold one of the pin-heads near the eye, and notice the point in the hillside where the line *P P* falls; pace to the spot, and note down the number of steps. Start afresh from that point to the next similarly determined, and again noting the number of steps; and so on. Thus on your note-book you will have entered a series of numbers; and that, in each of the intervals so noted, you have ascended by the height of your own eye above the point at which you started. Should the hillside be too steep to pace it, a measuring tape may be used. By ruling on a piece of paper parallel lines at the distance of the height of your eye to the scale you wish to use, it is extremely easy to lay down the contour of the hill from these notes.



I remain, Sir, faithfully yours,
O. Fisher.

Elmstead, Colchester, November 3rd, 1863.

BRITISH ASSOCIATION MEETING AT NEWCASTLE.

(*Continued from p.* 395.)

ON SOME FOSSIL AND RECENT FORAMINIFERA COLLECTED IN JAMAICA BY THE LATE MR. LUCAS BARRETT, F.G.S.

By Professor T. Rupert Jones, F.G.S., and W. K. Parker, Esq.

In 1862 Mr. L. Barrett, F.G.S., late Director of the Geological Survey of the West Indies, gave Messrs. Jones and Parker some fossil and recent Foraminifera from Jamaica, comprising a few new forms—some that were previously but little known, and some in finer condition of growth than usual. The recent specimens, from their ascertained habitats, illustrate, to some extent, the conditions under which the fossil forms were deposited.

One sample of these fossil Jamaican Foraminifera consisted of several specimens of *Amphistegina vulgaris*, and another of a few of the same species, with one *Textularia Barrettii* (a new variety of *Textularia*). No locality nor geological horizon was indicated for these. A third sample, from "South Hall Cliff," consisted of two large specimens of *Vaginulina legumen.* Fourthly, a much larger series of Foraminifera, from the "Pteropod-marl" of Jamaica, affords *Nodosaria Raphanistrum, Dentalina acicula, Vaginulina striata, Frondicularia complanata, Cristellaria calcar, C. cultrata, C. rotulata, C. Italica, Orbitolina vesicularis, Bulimina ovata, Cuneolina pavonia, Vertebralina striata*, and *Lituola Soldanii.* These, however, can be regarded only as an incomplete Rhizopodal fauna.

From the recent Foraminifera obtained by the late Mr. Barrett from different sea-zones, between 15 and 250 fathoms, on the Jamaica coast, we learn that *Amphistegina vulgaris, Textularia Barrettii, Dentalina acicula, Frondicularia complanata, Cristellariæ*, and *Lituola Soldanii* indicate at least 100 fathoms, and probably more, as the depth at which the Pteropod-marl and the Amphistegina-beds were deposited in that region. Pteropods are found in some sea-muds at similar depths.

Of the recent Jamaican specimens (evidently only the larger and more conspicuous members of a rich Rhizopodal fauna), some were taken at from 15 to 20 fathoms, namely, *Quinqueloculina agglutinans, Q. pulchella, Orbiculina compressa*, and *O. adunca;* some at from 50 to 100 fathoms, namely, *Orbiculina compressa, Dentalina acicula*, and *Orbitolina vesicularis*; and several others at from 100 to 250 fathoms, namely, *Dentalina acicula, D. communis, Cristellaria rotulata, C. cultrata, C. calcar, Frondicularia complanata, Amphistegina vulgaris, Polytrema miniacea, Bigenerina nodosaria, Verneuilina tricarinata, Textularia trochus, T. Barrettii, Cuneolina pavonia, Lituola scorpiurus*, and *L. Soldanii.*

Cuneolina, a rare form, hitherto known only by figures, and description given by D'Orbigny, proves (as suspected) to be a modification of *Textularia;* and *T. Barrettii* is intermediate between it and *Textularia* proper. The *Frondicularia* are remarkably large and beautiful; and the *Cristellariæ* and *Dentalinæ* are also large and relatively abundant.

This fauna is almost identical with the fossil Foraminifera of the Tertiary "Pteropod-marl" of Jamaica, above mentioned, specimens from which also were given by the late Mr. Barrett in 1862 to the authors of this notice.

ON THE BIVALVED ENTOMOSTRACA OF THE CARBONIFEROUS STRATA OF GREAT BRITAIN AND IRELAND.

By Professor T. Rupert Jones, F.G.S., and J. W. Kirkby, Esq.

(*Read before the British Association, at Newcastle, September*, 1863.)

After a review of what former observers have published on the Bivalved Entomostraca of the Carboniferous formations, the authors proceeded to point out—1st, a few rather doubtful *Cyprides* or *Candonæ*, from the coal-measures. 2ndly, *Cytheres;* of which there are about eight species, chiefly from the coal-measures. 3rdly, *Bairdiæ;* about eight species, mostly from the mountain-limestone and its shales. 4thly, *Cypridinidæ;* comprising *Cypridina, Cypridella, Cyprella, Entomoconchus*, and *Cytherella*, from the mountain-limestone; a fine collection of these rare forms from Little Island, Cork, liberally placed at Messrs. Jones and Kirkby's disposal by Mr. Joseph Wright, well elucidate the relationships of these hitherto obscure genera and their species. 5thly, *Leperditidæ;* comprising *Leperditia* (to which genus belong the so-called *Cypris Scotoburdigalensis, C. inflata, C. subrecta, Cythere inornata*, and others; many of them dwarf varieties of one species, and mostly belonging to the mountain-limestone series); *Entomis* (mountain-limestone), Devonian and Carboniferous forms of which have been mistaken for *Cypridinæ; Beyrichiæ* (from nearly all parts of the Carboniferous system), several species, of which *B. arcuata*, Bean sp., is the most common; and *Kirkbyæ*, somewhat rare, and chiefly from the mountain-limestone series.

Leperditia and *Beyrichia* are also Silurian and Devonian genera; they do not appear to pass upwards into the Permian formation. *Bairdia* and *Kirkbya* occur first in the Carboniferous, and reappear in the Permian deposits, even in the same specific forms; and *Bairdia* has been freely represented in Secondary and Tertiary deposits, and exists at present. Of the *Cypridinidæ* under notice, *Cypridella, Cyprella*, and *Entomoconchus* appear to be confined to the mountain-limestone; *Cypridina* occurs in the Permian, and with *Cytherella* is found in Secondary and Tertiary rocks, and in existing seas. *Entomis* is a Silurian and Devonian genus, especially characterizing the so-called "Cypridinen-Schiefer" of Germany.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

LIVERPOOL GEOLOGICAL SOCIETY.—Amongst the papers of the last session are :—"On the Ancient Glaciers of Snowdon," by Mr. G. H. Morton, who gives an account of the experiences of two days spent on the mountain, and describes the group included under that name,—the highest peak, Pen Wyddfa, being 3571 feet above the sea. "On the Lingula-flags and Strata beneath," by the same author, who describes at considerable length the principal localities in Europe and North America where the Lingula-flags and Lower Llandeilo strata are developed, and in conclusion, states that "the fossils of the Lingula-flags embraced many varieties of form, and that though there are cosmopolitan species, there are others of more limited range in space. The result of geological investigation in the Cambrian rocks has brought to light but very scanty traces of early life, it being only in the strata of that age, at Church Stretton and Bray Head, that any such indications have been found. It is, however, remarkable that crystalline limestone should occur in the still lower Laurentian system, for if this rock was formed, like other limestones, of comminuted fragments of shells and corals, since altered by a high temperature, then the theory of such rocks being *azoic* is groundless, and we have yet to become acquainted with the most ancient life-creation."

Report of the Field Meeting at Storeton, on Monday, the 7th of July, 1862,—when Mr. Morton exhibited for the first time a section drawn to scale, showing each important bed that occurs in the oldest of the Storeton quarries—the south quarry. The interesting faults, and the position of the Keuper Sandstone, in a fissure of the Bunter Sandstone, cause this section to be very remarkable and instructive.

A field meeting was held at Leasowe, September 20th, 1862, when the members visited the interesting sections of the submarine forest beds at Leasowe Lighthouse and Dove Point.

"On the Geology of the Thames Valley." By Mr. W. S. Horton, F.G.S. The physical features of the district consist of a succession of low terraces overlooking the valley of the Thames, or Isis, presenting to the course of that river their more abrupt flanks, and gently sloping down in the opposite direction. This terrace-like succession is a true index to the stratigraphical structure of the district, as it will be found that each of them is composed either of limestone or some other firm rock, resting upon a basis of clay, which forms the intervening valley. The formations occupying the tract of country described in this paper are in descending order ; the Post-Pliocene (represented by the high-level gravel and the estuarine, or low-level gravel) ; the Lower Cretaceous (the Shotover Sand and Lower Greensand) ; and the Upper and Middle Oolites, consisting of the Purbeck beds, Portland Stone and Sand, Kimmeridge Clay, Upper Calcareous Grit, Coral Rag, Lower Calcareous Grit, and Oxford Clay. The Oxford Clay occupies a considerable area, extending northward from the ridge of the Coral Rag, but, as for the most part it is level ground, and generally covered by the Estuarine gravel, but very few sections occur. Its thickness is very considerable ; at Wytham Hill it was ascertained from a boring to be 600 feet ; it is, however, probable that thickness is somewhat exceptional, as at St. Clement's, on the other side of Oxford, it is reduced to 265 feet. Crystals of selenite and iron pyrites occur, but fossils are by no means plentiful, and only locally preserved. The Coral Rag and its associated beds—the Upper and Lower Calcareous Grits—form a low terrace, rising somewhat abruptly from the low ground of the Oxford Clay, and overlooking the valley of the Isis. In a large quarry, at Kingstone Bagpuze, the Upper Grit may be observed resting on the Coral Rag, which in its turn reposes on the Lower Grit. At Wheatley, to the north-east of Shotover, these beds form an anticlinial, or dome, dipping under the Kimmeridge Clay, in every direction from the centre. The Coral Rag, in this neighbourhood, contains its usual assemblage of zoophytes and echinoderms. The Kimmeridge Clay extends along a band of country following the course of the Coral Rag, and resting upon the southerly slope of the terrace formed by that rock. Its organic remains do not offer any important differences from those of the Oxford Clay; indeed, many of them are common to both formations. The best sections of the Kimmeridge are at Headington, near Oxford, and Culham, near Abingdon. The Portland beds extend in a narrow band round the Shotover ridge of hills. At Combe Wood, near Cuddesden, a small patch of Purbeck beds may be observed resting on the Portland Stone. They consist of about four feet of grey marly limestone, containing Cypris, Mytilus, and Paludina. At Culham, the Gault and Lower Greensand may be observed reposing on a base of Kimmeridge Clay. The Gault at this place is a blue laminated clay, with its characteristic fossils, *Ammonites lautus*, *A. interruptus*, *Nucula pectinata*, *Inoceramus concentricus*, and *Plicatula pectenoides*. The Lower Greensand contains no fossils in the neighbourhood of Oxford, but at Faringdon the remarkable gravels of this age are almost entirely composed of sponges, bryozoa, and mollusca. The freshwater sands of Shotover have been the subjects of essays by several writers, who all agree as to their freshwater origin, but are not so unanimous as to their geological date; some being inclined to regard them as being the equivalent of the Hastings Sands, or Wealden beds, and others as an estuarine condition of the Lower Greensand. Professor Phillips is of the latter opinion, and it seems to be the safer course to regard them as an exceptional condition of the Greensand. They contain very few fossils; those that have been collected belong to the genera Paludina, Cyrena, Unio, and Cypris. These beds are valuable, as producing the well-known Oxford ochre. The high-level gravel belongs to the period of the northern drift, and is so called because it occupies the highest ground in the district, as at Wytham Hill, where it attains an elevation of 583 feet above sea-level. It does not contain any organic remains, and is composed of well-rounded quartz pebbles. The low-level gravel is quite distinct in its origin, being formed almost entirely of local rocks, and containing water-worn Oolitic fossils, such as Terebratulæ, and fragments of Belemnites. South of Abingdon, where the surface-rocks are cretaceous, it passes into a flint gravel, evidently derived from the denudation of the chalk of the district. The only remains belonging to the period when it was deposited are those of elephants, probably *Elephas primigenius*. From the position of this gravel, which extends into the valleys of the Windrush and Evenlode, and other tributaries of the Thames, we may conclude that it was formed at a comparatively recent period, when the ridges of Coral Rag were dry land, and what are now river-valleys were a series of shallow lochs, similar to those on the west coast of Scotland.

At the meeting of January 13th, 1863, the President, the Rev. Professor Henry Griffiths, in his Address referred at length to some interesting geological phenomena, peculiar to North and South Wales, with regard to the Old Red Sandstone, and particular attention was drawn to that system of strata. The President then minutely described the series of fossil ichthyolites of that age, lately added to the collection of the Royal Institution.

"On the Wigan Coalfield." By Mr. S. B. Jackson.—The area treated of was illustrated by Farrimond's valuable mining map and list of strata. These served also to indicate the multitudinous "faults" and dislocations of the district, and the "outcrops" of the numerous seams of coal by which it is enriched. The Wigan coal-field contains the lower and middle series of the Lancashire coal-measures. The former are thrown up at Billinge and Up-Holland, present a lofty range of hills, and divide the Wigan from the St. Helen's coal-field. With this exception, the superficial aspect of the region is undulating, and presents no remarkable natural feature. The Millstone Grit constitutes the lowest known rock in the district, and the portion exposed at Grimshaw Delf is about 100 feet thick; resting upon it are the lower coal-measures, 1800 feet in thickness. They consist of a series of micaceous flags, shales, and thin beds of coal, with their floors of underclay, containing Gannister, a peculiarly hard siliceous stone, which, in the first instance, gave the name of "Gannister beds" to the series in which it is found. They contain six seams of coal, designated "Mountain Mines," having an aggregate thickness of about nine feet. Only two of the seams have been found worth working, and those to a limited extent. The sandstones of this series are even-bedded, showing ripple-marks and sun-cracks, and are very extensively used for flagging and roofing-purposes, splitting along planes, formed of micaceous flakes. A good section of the lower measures may be seen in the cutting of the Lancashire and Yorkshire Railway between Pimbo Lane and Up-Holland Stations. Resting upon the micaceous flagstones, just referred to, is the base of the middle coal-measures, which attain a thickness of about 2400 feet. They consist of an alternating series of reddish-grey and yellow sandstone, shales of various character, and beds of coal, with their under clay. This series is the most prolific of coal, containing not less than forty-five seams, with an aggregate thickness of 100 feet. Two-thirds of the number of seams, ranging from two to thirty-two inches, with a total thickness of thirty-three feet, are either impure or too thin to pay for working. The remaining fifteen seams contain about sixty-seven feet of coal, and are those which are exclusively worked in the Wigan coal-field. These range from about two to ten feet in thickness. The properties and qualities of the respective seams of coal differ considerably, as do also remote and detached areas of the same seam. Generally speaking, the whole may be grouped into three classes, viz. the Free-burning, the Bituminous, and the Cannel Coals, of each of which this field furnishes an ample and excellent supply. As a rule, the seams which exceed four feet in thickness are inferior in value to those which are four feet or under, and in most cases the quality near the outcrop is not so good as in the deep. The most valuable seam in this series is the Cannel Coal, and next to it the Orrell Four Feet, or Arley Mine, which at Wigan closely resembles the famous Wallsend of the Newcastle field. This seam being the lowest, is sometimes worked at a great depth. At the centre of the Wigan basin (say under Wallgate), it is about 863 yards from the surface. Our limits preclude a particular description of the several seams. Notwithstanding differences of thickness in strata, and of the quality of the various seams of coal in the two districts, there exist such analogies between the coal-beds of Wigan and those of St. Helen's that miners entertain no doubt of their identity. Indeed, the prevalence of a thick bed of *Anthracosia robusta*, commonly called the "Cockle-shell Bed," occurring upon a substratum of under clay, about sixty feet above the Arley mine, taken in conjunction with the nearness of the Gannister beds below, enables the geologist to identify the strata at the base of the Middle Coal-measures of Lancashire wherever they occur. A series of great "faults," or dislocations, running almost parallel with each other in a N.N.W. direction, and nearly equidistant, divide the coal-field of Wigan into a succession of belts. Minor faults branch away from the main faults in all directions, and break up the strata into numerous subdivisions. Moreover, each fault and branch fault has a certain and considerable inclination to one side or another in its course, varying from one to three vertical to one horizontal. Hence every locality requires to be "proved," either by boring or by the sections of adjacent collieries, so that in sinking a shaft the miner may avoid faults, and "win," at the least outlay, the greater number of seams of coal. The forces which occasioned the dislocations have diminished in power northwards, and the extent of their "upthrows" and "downthrows" vary over the field in question from a few yards to upwards of six hundred. The effect of great upthrows has been the loss of many valuable seams in some localities, and that of downthrows to preserve them, while their combined result has been in one part of the field or another to cause every seam to have one or more "outcrops." The courses of these "outcrops" are clearly traced on the recently-coloured maps of the Geological Survey, and some of the most favourable situations for viewing them, as well as sections of the district, are given in the memoirs of that survey, by Mr. Hull. The coal-bed roofs of the lower measures of Wigan include remains of drifted plants and Sigillariæ, and, in the under-clays, Stigmaria. The "floors," or under-clays of the coal-beds of the middle measure abound with Stigmariæ, or the roots of Sigillariæ, the stems of which occasionally intersect a coal-bed, but are generally found in the roof. Especially is this the case in the roof of the Four Feet Ince Mine, where, from their upright position and ponderous weight, and the nature of the roof itself, they are the frequent cause of melancholy accidents. The coal-beds themselves are vast depositories of fossil vegetation, the forms and tissues of which are for the most part obliterated; but in the roofs are found, beside Sigillariæ, numerous Ferns, Asterophylites, Calamites, Lepidodendrons, and Coniferæ. The fauna of the Lower Coal-measures of Wigan furnish Anthracosia, Modiola, *Goniatites Listeri*, and *Aviculo-pecten papyraceus*. In the roof of the Lower "Mountain Mine" is a fish-bed containing bands, full of Cypris or Cythere, *Microconchus carbonarius*, Anthracosia, and more rarely Goniatites, fish-bones, scales, teeth, etc. The middle series contain *Anthracosia robusta* in abundance, and the varied remains of two fish-beds, one over the Arley and the other over the Cannel mine. From Mr. Hull's memoirs we learn also that the late Mr. Peace, mining-agent to the Earl of Balcarres, collected from the latter bed beautiful specimens of fish, of the genera Megalichthys, Holoptychius, Diplopteris, Ctenoptychius, and some large dorsal rays. Some idea of the immense value of this coal-field may be deduced from Mr. Hunt's Mineral Statistics for 1861. He gives the total quantity of coals raised that year in the United Kingdom as 83,635,214 tons, of which 12,195,500 tons were raised in Lancashire. The number of collieries (not pits) then in Lancashire was 375, the proportion in the Wigan district being 78. An uniform average quantity for each colliery would show the produce of the Wigan coal-field that year to be about 3,000,000 tons. Eight shillings per ton at the pit's mouth,—a low enough estimate for Cannel and all sorts,—would give £1,200,000 as the produce of the mines for one year. The facilities at some of the Wigan collieries for executing extensive orders for shipment in a very short time are surprising. At Rose Bridge Colliery, for instance, the property of Messrs. Case and Morris, Mr. Bryham, the able and obliging manager, states they can raise with ease a thousand tons per day, or fifteen hundred tons in the twenty-four hours, by working night and day.

"On the Geology of the Egyptian Desert." By Mr. H. Duckworth, F.G.S.—Egypt, with its desert tracts, covers an area of about 100,000 square miles. In form it is an irregular parellelogram, the longest axis of which runs north and south. It is that desert tract, east of the Nile, which forms the subject of this communication, generally known as the "Egyptain Desert," and which, from its connection with the Overland Route and the Suez Canal scheme, has had more than an ordinary amount of attention directed to it. The desert which stretches between Cairo and Suez is more varied in aspect than those who are acquainted with it might be disposed to believe, the ground being everywhere broken up into a series of undulating tracts, or shallow ravines, called by the Arabs "Wadis," whilst the mountain ranges of Jebel Mukattam, Jebel Reibun, and Jebel Attakah, form a complete barrier towards the south. The surface of the land presents generally the appearance of a gravelly beach, pebbles and angular fragments of jasper, chert, quartz, gypsum, and sandstone being largely intermingled with sand. Vegetation is not altogether absent, and in the Wadis several ligneous and herbaceous plants are found, among which are the *Acacia Ægyptiaca*, the *Astragalus hamosus*, and the *Fagonia latifolia* (*Sieberi et tumidus*). The height of the desert varies considerably, but its extreme elevation above the sea may be stated at about 700 feet. Its general character is that of an elevated plateau, rising towards the centre and gradually sinking until it terminates in bold escarpments on the banks of the Nile on one side, and on the shores of the Red Sea on the other. These cliffs are composed for the most part of Nummulitic limestone, which we find extensively developed throughout Egypt and Nubia and a great part of the Sinaitic peninsula. Overlying this limestone are patches of a sandstone formation, associated with calcareous gypsums and saline marls, and stretching from the Mediterranean Sea far into the Nubian and Libyan deserts. The absence of its beds at certain points has evidently been caused by denudation, and the sands and gravels of the desert may be regarded as the débris of this formation. The beds of this sandstone vary in thickness from a few inches to 180 to 200 feet. Silicified monocotyledonous wood is found in great abundance in this deposit, especially in the vicinity of Cairo, where the remains are so well preserved, and of such magnitude, as to be popularly known as the "Petrified Forest." The wood-stems in question are invariably found in a horizontal position, and there is no evidence to show that they originally flourished *in situ*.

Professor Unger, of Vienna, states that the trees belong, without exception, to one species, for which he proposes the provisional name *Nicolia Ægyptiaca;* and further, that the sandstone in which they occur is strictly analogous to a formation containing wood-stems near Gleischenburg, in Styria. He supposes the masses of wood to have been drifted into a basin separated from the main sea, and filled with water saturated with silica,—an hypothesis which appears to me extremely probable.

"On the Composition of Black Sandstone occurring in the Trias around Liverpool." By Mr. A. Norman Tate, F.C.S.—These deposits are found in the sandstone of Flaybrick, Storeton, Toxteth Park, and other places. The author's attention was directed to them by Mr. Morton, and he has since examined them chemically to ascertain their composition. On treating them with hydrochloric acid, chlorine gas was evolved, and the dark-coloured portion dissolved, leaving a residue of white sand. A quantitative analysis showed that, next to silica, the principal ingredient was peroxide of manganese. One sample contained as much as 10 per cent. of that substance, whilst in others the quantity did not exceed 3·5 per cent. To the presence of this peroxide of manganese the black colour is evidently due.

It does not exist throughout the entire mass, but merely coats the grains of sand. As far as he had yet noticed these deposits, they appear to occur most frequently in bands of from a mere line in thickness to ¼ inch; but they are also found distributed in patches and small lumps throughout the mass of the rock. In several pieces the black sandstone was distributed much in the same manner as currants in an ordinary cake. The deposits described must not be confounded with other dark-coloured portions of the sandstone. Some sandstones undoubtedly owe their dark colour to the presence of organic matter, derived from the overlying vegetable mould, whence it is extracted by water and conveyed to the rocks beneath. In some dark-coloured sandstones protoxide of iron may also be found.

"Description of the Footprints of Cheirotherium, and of an Equisetum, found at Storeton, Cheshire." By Mr. Morton.—The author referred to the original description of the Cheirotherium footprints found at Storeton, as given by John Cunningham, Esq., F.G.S., in 1838. He proposed the provisional name of *Cheirotherium Storetonense* for the smallest of the following three, from different places in Cheshire,—*Cheirotherium Hercules*, Tarporley; *C. Kaupii*, Lymm; *C. Storetonense*, Storeton. About the time the footprints were discovered, the reed-like stem of a plant was found at the same place. Lithographs of both were published by the late Natural History Society of Liverpool. The fossil reed is now in the museum of the Royal Institution. It has been examined by Mr. F. M. Webb, who described it as the upper portion of an Equisetum, but without any remains of fructification. In Professor Morris's catalogue of British fossils there is no species of the genus, but one from the Keuper of Würtemberg is inserted. The author proposes the name *Equisetites Keuperina.*

"On the Corals of the Silurian Sea." By Mr. Morton.—The author remarks "that if the great development of the septal arrangement in the Zoantharia indicates a higher organization of the polyp, most of the Silurian corals certainly belong to lower forms of that order than those common at the present time. We must, however, remember, that as we find the two suborders, tabulata and rugosa only, in the Devonian, Carboniferous, and Permian systems, it cannot be said that the Silurian differs, except by the addition in its upper strata of Palæocyclus; and if we include that genus in the suborder Aporosa, the coralline fauna as a whole is absolutely higher than that of any other more recent palæozoic epoch. If Palæocyclus really belongs to the family Fungidæ, it is very remarkable that no recurrence of the suborder Aporosa has been noticed until after the close of the Palæozoic period."

"The earliest Llandeilo corals known seem to belong to *Zoantharia tabulata*, and do not differ materially from those of the same suborder in the Upper Silurian. *Pyritonema* is a peculiar genus, while *Heliolites catenularius* occurs from the Llandeilo to the Wenlock strata inclusive. No early examples of *Zoantharia rugosa* have been discovered, and it does not appear that the earliest forms of coralline bodies were the lowest of their order. Few and fragmentary, however, are the corals of the Lower Silurian, and not even a trace has come to light from the still more ancient Cambrian, so that our knowledge after all is very scanty and uncertain about them."

Manchester Philosophical Society.—*October* 20.—"Further Observations on the Carboniferous, Permian, and Triassic Strata of Cumberland and Dumfries," by E. W. Binney, F.R.S., F.G.S. When, in 1848, the red sandstones of the neighbourhood of Dumfries first came under the author's observation, in company with his friend Professor Harkness, doubts came into his mind as to the propriety of their being classed with the Trias, their characters and organic remains clearly indicating more of a Permian age.* Accordingly, in his first paper published on this subject in the Society's Memoirs† in 1855, allusion was made to these beds, and they were classed as Permian after tracking the Permian beds of Lancashire through the north-western counties of York, Westmoreland, and Cumberland. His attention was chiefly directed to the red marls, magnesian limestones, conglomerate, and soft red sandstone strata, those being the common Lancashire types; and where the red sandstones of the neighbourhood of Carlisle and St. Bees were incidentally mentioned, they were treated as Upper New Red Sandstone or Trias, as Professor Sedgwick has described them in his valuable memoir. But in his second communication,‡ published in 1857, where the Howrigg, Shawk, and Westward sections are described, he came to this conclusion that "the brick-red sandstones of those places, with their underlying red clays, as well as the breccia at Shawk, I have little doubt will be proved to be Permian. It is true that no fossil organic remains have yet been found in them, with the exception of the track alluded to in this paper; but if mineralogical characters and geological superposition are to be taken as evidence of their age, they are as good Permian beds as those of West-House, Kirby Stephen, and Brough, in England, and Dumfries and other places in the south-west of Scotland, with the latter of which they are most probably connected."

In a paper published by Professor Harkness in 1862,§ that geologist adopts in substance this view, and agrees with the author's opinion of the Howrigg, Shawk, and Westward red clays and sandstones being of Permian age, and describes a very beautiful section at Hilton, in Westmoreland, which strongly confirms it. Of course, it was not intended to question the Triassic age of the soft red sandstones of Dalston and Holmhead, near Carlisle, which are covered by waterstones, red marls, and lias, as stated in the author's paper on the latter deposit.‖

The Shawk sandstones are well seen at Westward Chapel near Wigton, West Newton, near Aspatria, near Allonby, and to the north of Maryport, and after the Maryport, Workington, and Whitehaven coal-field is passed, they appear again to the south on the coast, in the magnificent promontory of St. Bees' Head, and continue southward certainly to Netherton, Seascales, Gosforth, and Drigg Cross, and probably, as Professor Sedgwick suggests, into Furness.

On the north of the Solway the Permian strata on the opposite side of the Vale of Eden are well exposed near Riddings Junction, on the Waverley line of railway, about Carwinlay, Moat, and Canobie, and the range of the Moat sandstone (the same age as that of Shawk) by Glenzier Quarry, Cove, near Kirkpatrick Fleming, above Annan, on to Dumfries, is well marked.

In addition to a description of several Permian sections at Penton, Riddings, Carwinlay Burn, Barrowmouth, and Ben How, two sections were given, which showed the occurrence of the upper coal-measures, similar to those described by the author some years since in the valley of the Ayr, near Catrine, and thus rendering it extremely probable that such coal-measures extend under the valleys of the Eden and the Esk, their southern outcrop being exposed in the Raw Reck, south of Dalston, and their northern outcrop at Canobie. These Carboniferous strata may not be rich in coal, but they contain the limestone of Ardwick, Leebotwood, and Ballochmoyle Braes (formerly termed a freshwater one), and show a great development of coal-measures, which are useful to be known if it be only to show the depth that has to be sunk through before the middle and profitable coal-fields of Whitehaven and Canobie can be reached. This portion of the coal-measures, both in Scotland and the north-west of England, has generally been termed Permian, and summarily dismissed as unprofitable "red measures." In the author's paper on the Ballochmoyle limestone,* it was shown that a great thickness of unprofitable coal-measures had to be traversed before the profitable coal-field at Common could be reached, in that district some 550 yards.

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* In the 'Quarterly Journal of the Geological Society for 1851,' p. 162, Sir R. I. Murchison doubted the sandstone of Dumfries being of Triassic age, and preferred to class it with the Permian.

† On the Permian Beds of the North-West of England, vol. xii. p. 209, of the Society's Memoirs.

‡ Additional Observations on the Permian Beds of the North-West of England, vol. xiv. p. 101, of the Society's Memoirs.

§ 'Quarterly Journal of the Geological Society for August, 1862,' p. 205.

‖ *Ibid.*, for May, 1859, p. 549.

The Canobie section exposes far more coal-measures above the limestone than the one at Ballochmoyle, at least 200 yards, and it shows a passage of Carboniferous into Permian beds, so far as the eye can detect, better than any that has hitherto come under his observation. The strata of these two formations in the bank of the river above the bridge at Canobie from the fine breccia into the underlying clays and shales are most difficult, if not impossible, to separate from the red shales and sandstones seen between that point and the bridge there.

The district about Canobie, Penton, and Longtown, has been described at length by Mr. Edmund Gibsone, in an elaborate and well-illustrated memoir printed in the Transactions of the North of England Institute of Mining Engineers.† In the Penton Linns' section that author describes the mountain-limestone seams of coal, in the Penton railway section the millstone grit series, and in the Canobie coal-field the middle series; and he shows a fault on the south of the latter coal-field which throws the coal-measures down and brings in the Permian strata. All the red measures south of this fault Mr. Gibsone appears to consider Permian, and the fault which brings them in he calls the Great Permian Fault. After examining these red measures, the author said he had come to the conclusion that although a portion of them are Permian strata, as Mr. Gibsone describes them to be, a great part of them are unquestionably upper coal-measures. The profitable Canobie coal-field, like that at Common in Ayrshire, belongs to the middle or valuable coal-field; but there is also at Canobie a great thickness of upper coal-measures containing a seam of limestone, in all respects like the Ballochmoyle Braes, near Catrine, the Ardwick and Leebotwood limestones. Consequently, the Permian fault should be called by some other name, say the Great South Fault.

Practical mining engineers have frequently classed all the red and variegated beds which they find in the upper part of the coal-measures as "red measures" or Permian strata. Now, there is no doubt often great difficulty in drawing the line of demarcation between the upper coal-measures and the Permian strata, and it is possible that, in some sections, one may pass into the other, as appears to be the case in the river-section above the bridge at Canobie, previously alluded to, but in the north-west of England this transition is not generally to be seen, The further we investigate the organic remains of these two formations, probably more genera and species will be found to be common to both than is at present supposed; but in all cases where the remains of Stigmaria and *Spirorbis carbonarius* (Microconchus) have been found in the strata, the author has termed them Carboniferous. In the absence of organic remains, which is generally the rule and not the exception, the Permian character of the strata has been decided by the mechanical character of the deposits and the order of superposition, the beds of breccia and the soft red sandstone generally affording pretty good evidence of the Permian age of the strata over a great extent of country, and varying with the character of the older rocks found *in situ* in the district. If the Permian beds are taken as the Moat sandstone, the red shales with gypsum and four breccias lying in soft red sandstone at Canobie and Riddings, their identification is pretty easy; but in continuing them downwards into the upper coal-measures, or in tracing their boundary upwards into the Trias, there is greater difficulty, as natural sections showing the passage of one into the other are not often with; but he considers the soft red sandstone of Longtown, West Linton, Rockliffe, and Dalston to be of Triassic age, and covered by the waterstones and red marls of Carlisle, and these, in their turn to the west, overlaid by the lias of Quarry Gill and Oughterby.

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* On some Upper Coal-Measures containing a Bed of Limestone, at Catrine in Ayrshire. ('Quarterly Journal of the Geological Society for August, 1862,' p. 437.)

† A geological paper on the Border Districts of Dumfriesshire, Cumberland, and part of Roxburghshire, including the coal formation of Canobie, etc., by Edmund Gibsone. (Vol. xi. p. 65.)

The Knotty Holm sandstone and a similar rock at Penton, especially in their lower portions, reminded the author of the Whitehaven sandstone, and it is possible that they may be of the same geological age as that rock, but for the present he has included them in the upper coal-measures.

In the valleys of the Esk and Liddel he described some interesting Permian sections, and detailed at length the particulars of the strata found over a distance of above twenty miles from the upper coal-measures at Canobie to the same beds, as seen in the Raw Beck, near Dalston, where the following strata are met with, viz.:—1. Red and variegated clays, 13 ft. 1 in.; 2. Bed of limestone with spirorbis, etc., 1 ft.; 3. Red clays, 10 ft.; 4. Purple shales containing stigmaria, 80 ft.; 5. Soft red sandstone, 40 ft.; 6. Purple shales, 16 ft. 2 in. After tracing the Shawk sandstone by Westward Chapel, Wigton, West Newton, near Allonby, to Maryport, he passed over the West Cumberland coal-field, and followed it by St. Bees to the south of Cumberland, as far as Drigg Cross. He described at length the Permian strata of Barrowmouth and Ben How, south of Whitehaven. At the former place the beds occurred in the following descending order, viz.:—1. Fine-grained red sandstone, laminated and ripple-marked, same as that seen at Moat, Glenzier, Cove, Shawk, Westward, Maryport, and other places, which may be conveniently termed the St. Bees sandstone, fully 1000 ft.; 2. Shaly marls, 30 ft.; 3. Red marls containing granular gypsum, 29 ft. 6 in.; Magnesian limestone of a cream colour, containing shells of Bakevellia and Schizodus, 10 ft. 6 in.; Breccia composed of pebbles of coal-measures, sandstones, and slate rocks, 3 ft.; Red and purple sandstones, 110 ft.; Conglomerate sandstone full of white quartz pebbles, with peroxide of iron and volcanic ash, containing common coal-plants, 30 ft. The two last beds have been long known as the Whitehaven Sandstone, and Professor Sedgwick many years since classed them as Lower Red Sandstone. After further investigation the author is inclined to indorse this opinion, as he cannot find any difference between these sandstones and his Lower Permian beds of Astley, Bedford, and Moira, near Ashby-de-la-Zouch. These singular sandstones lying unconformably to the breccia above and the coal-measures underneath, he thinks will be found to be the English representatives of the Lower Rothliegendes of the Germans.

The author showed that although the upper coal-field of Lancashire and the Midland Counties of England contained several workable seams, the same beds in Cumberland and Scotland contained none. On the other hand, the mountain-limestone series in the latter districts contained numerous seams of coal, whilst none were to be found in the former.

GEOLOGICAL SOCIETY.—*November 4th*, 1863.—1. "On some Ichthyolites from New South Wales sent over by the Rev. W. B. Clarke, F.G.S." By Sir P. de M. Grey Egerton, F.R.S.

Two specimens and three photographs, sent to England for the author's determination, enabled him to distinguish four genera, two of which are new, and allied to Acrolepis and Platysomus respectively; the known genera being Urosthenus, *Dana* (allied to Pygopterus), and Palæoniscus, *Agass.* Sir Philip was of opinion that these genera were sufficient to stamp the deposit in which they occur—namely, the coal-formation of New South Wales—as belonging to the Palæozoic period, if they may be regarded as representative genera living at the same period as, but geographically distant from, their nearest allies; but, as regards the actual age of the formation, the allied genera are more abundantly represented in the Magnesian Limestone and the Kupferschiefer than in the coal-measures; the materials were, he considered, too meagre to justify a conclusion.

2. "Notes on the Geology of a portion of the Nile Valley north of the Second Cataract, in Nubia, chiefly with the view of inducing further search for Fluviatile Shells at High Levels." By A. Leith Adams, A.M., M.B., Surgeon 22nd Regiment. With a Note on the Shells, by S. P. Woodward, Esq., F.G.S.; and a Note on some Teeth of Hippopotamus, by Hugh Falconer, M.D., F.R.S.

In company with the late Mr. A. H. Rhind, F.S.A., the author made the usual boat-voyage from Cairo to the Second Cataract during last November and the two following months, when he was enabled to make some observations on the geology of that portion of the Nile valley. In this paper he first described the physical features of the district, beginning at Selsileh and proceeding southwards, and then the lithological and stratigraphical characters of the Nile sandstone, as well as its mode of junction with the granite, noticing also the evidences of the Nile having shifted its bed, and of other physical changes occurring in Nubia. Near the Second Cataract were abundant proofs of the river having formerly flowed at higher levels, the author having found river shells, such as *Cyrena fluminalis*, *Paludina bulimoides*, *Iridina Nilotica*, and *Œtheria semilunata* (the Nile oyster), as also *Bulimus pullus* and a Unio like *U. pictorum*, in beds of alluvium on elevated plateaus at various heights, ranging up to 130 feet, above the highest inundations of the present day.

Dr. Adams concluded from these facts that the Nile was formerly a more rapid river than it is now, and that the force and wearing power of the stream has been steadily declining since the upheaval of the valley ceased.

The determinations of the shells were made by Mr. Woodward, who gave a complete list of them in a note. Dr. Falconer also described two molars embedded, *in situ*, in a fragment of the left maxillary of a very large hippopotamus; the specimen was dug up near the old temple of Kalábshe, in Nubia; and Dr. Falconer was of opinion that it belonged to the same species as the existing hippopotamus of that country.

November 18.—1. "On the Fossil Corals of the West Indies."—Part II. By P. Martin Duncan, M.B., F.G.S.—This communication consisted chiefly of a description of corals returned to the Society's Museum by Mr. Lonsdale soon after the reading of the first part.

The predominance of simple fossil corals in San Domingo, and their complete absence in Antigua, were pointed out; and it was remarked that the same kind of distribution occurs at the present day, pedunculated compound forms being very common around the northern Antilles, but rare around the north-eastern, although the corals are mostly of different genera to those found in the fossil state. The author concluded with some remarks on the physical conditions of the Miocene period in the West Indies, observing that the Nivaje shales and associated deposits are the remains of an ancient barrier-reef, and giving an analytical table of the affinities of the species, in which it was shown that the Pacific and East Indian element greatly preponderated.

2. "Notes to accompany some Fossils from Japan." By Captain Bullock.—There having been no geologist attached to the late surveying-expedition of H.M.S. 'Dove,' the commander of that vessel endeavoured to repair the deficiency, so far as his professional duties would allow, by collecting fossils, and recording their localities. The specimens were presented to the Geological Society.

3. "On some Miocene Mollusca from Mount Séla, in the Island of Java." By H. M. Jenkins, Esq., F.G.S. With a Description of a new Coral from the same Locality, and a Note on the Scindian Fossil Corals. By P. Martin Duncan, M.B., F.G.S.—A short notice of the scanty literature of Javan geology having been given, the author described briefly the geological and physical features of the Mount Séla district, and made some general observations on, and gave descriptions of, the fossils which were the subject of the paper, and which had been sent to England by M. Corn. de Groot. Of sixteen determinable species, only three are now known to exist, the remainder being new species; but the fossils were probably more recent than this small percentage of living species would appear to indicate, there having occurred an emigration eastward of at least a part of the Southern- and Middle-European Miocene and Eocene fauna, as was proved by the identity of many species in the European Miocene, which now exist in the eastern seas, and also by certain genera being represented in that formation and the Eocene, and confined in the living state to the Indo-Pacific region. One of the Javan species being closely related to *Vicarya Verneuilii* from Scinde, the author was induced to investigate the claims of the Nummulitic formation of India to be considered altogether of Eocene date; and he inferred that there was a probability of some of the beds belonging to a less remote period. This inference was supported by Dr. Duncan in a Note upon the Scindian Fossil Corals, many of which (unnamed by M. Haime) were shown to have Miocene and recent, but not Eocene, affinities. The author next referred to the diminutive character of many of these Javan fossils, and then reviewed the opinions of former writers upon the Tertiary formation of that island, coming to the conclusion that the Mount Séla shells were probably of late Miocene date, and that the plants described by Dr. Goeppert were probably newer than the Eocene. The fossil coral from Mount Séla was shown by Dr. Duncan to be allied to *Astræa quadrangularis,* the habitat of which is unknown.

FOREIGN INTELLIGENCE.

The shores of the Caspian Sea had been shaken by frequent and violent earthquakes and eruptions during the early months of 1859, when Captain Kumany and Lieut. Petrof, of the Russian navy, discovered that a new island had been raised in that sea.* Mr. Abich visited the island on June 20th, 1859, and found that it had an elliptical shape, between 400 and 500 paces in circumference, very slightly convex, and with a small loamy flat area, bearing round shallow pools of water, kept in continual motion by the rising of gas-bubbles. The island was then 286 feet long and 225 feet broad. Its height (found by Captain Kumany to be 18 feet) had already lessened to 11½ feet. At the end of July it was only 6 feet high; and in November it had disappeared below the sea-level. In 1862 there was an increasing depth of water at the place; and in January, 1863, there were 12 to 13 feet of water there. Mr. Abich proposes that the island should be known as Kumany Island, in honour of the officer who first ascertained its existence.

The island had risen from a flat sea-bottom of sandstone and marl, in 75 feet depth of water, and 1000 feet from the shore. The eruptive action had evidently worked directly upwards through a conical accumulation of mechanically divided rock-substances, altered hydro-chemically, and such as might be derived from the sandy and gritty members of the molasse formation that exists on the neighbouring shores of the Caspian. According to Captain Kumany, the materials of the newly-raised island were tough and very hot, the temperature increasing with the depth. Mr. Abich found the island to have a temperature of 28°·4 R. (95°·9 F.), the atmospheric temperature being 20°·3 R. (77°·6 F.). By his further investigations, including chemical analysis, Mr. Abich finds that the muddy lavas of the Caspian region show evident analogies with certain tufaceous rocks of southern Italy; and that those of them which are insoluble in hydrochloric acid correspond to the normal siliciferous eruptive trachytic porphyries of Armenia and the Ponza Islands. He thinks that probably a formation of such porphyries, overlaid by sediments, extends over the central area of the Caspian Sea, and that the muddy lavas originate from a kind of trachytic tuff, forced upwards through vein-like fissures. The existence of two systems of fissures, intersecting each other at oblique angles, appears evident to Mr. Abich from the situation of the insular mud-volcanos in the Caspian, of the islands raised from its bed, and of the fumaroles, naphtha-springs, and mineral waters on its shores, by the lines of earthquake-shocks (Alat, in the summer of 1860), and by a vein of substances, analogous in composition to the mud-lavas of Kumany Island, filling a crevice in a valley of elevation near Teflis.

A piece of yellow amber,† flattened and round, 3 inches long and about 2 inches broad, found in a Tertiary sand, at about 18 feet beneath the surface, near Polnisch-Ostrau, in Austrian Silesia, is remarkable on account of having its external crust, of a deep honey-yellow tint, completely hardened, whilst its interior, yellowish-white, pellucid, and homogeneous portion still preserved its original soft resinous consistence.

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* 'On a Volcanic Island in the Caspian Sea.' By Dr. H. Abich and Director W. Haidinger. (Read before the Imper. Geol. Institute of Vienna, June 16, 1863.) [Communicated by Count Marschall.]

† Director Haidinger, Proceed. Imp. Geol. Instit. Vienna, May 19, 1863.

A well-preserved upper jaw of *Anchitherium Aurelianense*[*] has been lately found in the brown coal of Leiding (Lower Austria); also a tooth, from the lower jaw, in the "marine sands" of Grossbach; and another, from the upper jaw, in the brackish "Tegel" of Nussdorf, near Vienna. This species was long ago stated by the late P. Partsch to occur in the Tertiary limestone of Bruck on Leytha (frontier of Lower Austria); but since that time it had not been met with in the Vienna basin; now, however, it is proved to have lived during each of three mammalian periods, the faunæ of which are found in this basin.[†]

M. Cornelis de Groot, Chief Engineer and Superintendent of the Dutch Colonial Mines in the East Indies, reports that the production of Tin in Banka and Billiton (Blitong) has been—in the eight districts of Banka—

In 1857	...4609·037	Netherland tons,	1000 kilogrammes each.
1858	...6028·013	,,	,,
1859	...5686·489	,,	,,
1860	...5175·621	,,	,,
1861	...5406·500	,,	,,

In Blitong (where M. de Groot first discovered and worked tin-ores in 1851)—

In 1856	...209·839	Netherland tons,	1000 kilogrammes each.
1857	...114·801	,,	,,
1858	...281·842	,,	,,
1859	...144·404	,,	,,
1860	...249·978	,,	,,
1861	...406·812	,,	,,

The fossils found at Grand-Manil, near Gembloux, by M. Gosselet, and referred by him to the Silurian period, but disputed by Messrs. Malaise, De Koninck, and Dewalgue as true Devonian, have been admitted by M. Dewalgue, after further researches by M. Malaise, to be Silurian. The genus *Trinucleus* is represented by fragments of *T. seticornis* and *T. Bucklandi*, of Bohemia. A fragment appears to belong to *T. ornatus*. To the genus *Calymene* are fragments of heads, pygidia, etc., nearly allied to *C. incerta*, of Bohemia; to the genus *Lithas* a head complete, analogous to forms of the second fauna of that country. Other fragments belong to the Silurian group of the genera *Encrinurus, Chromus, Zethus,* and *Endymene*. Lastly, pygidium of *Homalonotus*. This locality also contains Graptolites, which are always regarded as characteristic of Silurian deposits.

M. Belval, Conservator of the Museum of Natural History at Brussels, in classifying the collection of Echinoderms, has come upon a new species belonging to the genus *Encope* of Agassiz, of the class of Scutellæ. It is near to the *Encope Michelini* of Agassiz, figured in pl. vi. fig. 9 and 10, of his Monograph of the Scutellas, but very distinct from all other species of this genus. This new species has received the name of *Encope Ghiesbrechtii*, in honour of M. Ghiesbrecht, the traveller-naturalist, who found it at Pernambuco, in Brazil, and presented it to the Brussels Museum. *E. Ghiesbrechtii* is distinguished from *E. Michelini* by being much larger, and not presenting that augmentation of height so remarkable in *E. Michelini;* the apical rosette is not prominent; the poriferous zones are narrower than the intermediate space.

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[*] Professor E. Suess and Dr. Zittel, Proceed. Imp. Geol. Instit. Vienna, May 19, 1863.

[†] See 'Geologist,' vol. iv. p. 497; and Quart. Geol. Journ. vol. xvi. Miscell. p. 1.

NOTES AND QUERIES.

Coal-Measures near Shrewsbury.—The geologists of the neighbourhood of Shrewsbury would confer a favour on a correspondent of the 'Geologist,' if they would forward by letter to the Editor, a few small pieces of the shale and limestone of the Upper Coal measures containing the *Cypris inflata*, described by Murchison, in his 'Silurian System,' p. 84, and in 'Siluria' (2nd edit.), p. 322.

British Association Report. — Dear Sir, — In the last part of the 'Geologist' you have made me the author of some remarks on Professor Harkness and Sir Roderick Murchison's paper "On the North-West Permians" (Sec. C. Brit. Assoc.), which were really uttered by Mr. Howse. I made no observations at all on the subject. Will you be good enough to correct the mistake in your next part?

Also in your report of Mr. Atthey's and my paper "On Animal Fossils from the Northumberland and Durham Coal-measures," it is stated that Messrs. Jones and Davidson are of opinion that the fossil from near Claxheugh is not a *Discina*, whereas they are of opinion that it *is* a *Discina*.

Believe me, yours faithfully,
J. W. Kirkby.

Sunderland, 26*th Oct.*, 1863.

Gamahes.—"We have already said that they are found in three sorts of things; in stones, in plants, and in living creatures. Those that are found in stones are called *Gamahes;* a word derived, in my opinion, from Camaïeu, by which name, in France, they call all coloured agates: so that from this particular name there is now made a generall appellation, serving to expresse all sorts of figured stones." . . . "Goropius Becanus, speaking of this kind of *Gamahe*, assures us that he hath seen bones that have been produced naturally within the bowels of the earth, which were of a prodigious magnitude, though they were generated of other matter; and of this kind peradventure are those bones whose vast bignesse hath caused people vainely to conclude that there have beene heretofore gyants in the world; so true it is, that for want of the true knowledge of the secrets of nature, men usually fall into most grosse errors. Now these embossed figures that are found in stones are of two sorts: the first are embossed round, as was the piece of rocke in forme of the Virgin Mary; and those bones that the earth naturally produceth, or only halfe-embossed, such as were those rocks which Ortellius makes mention of, scituate in the entrance of the most western part of Tartary: on which are to be seen the figures of camels, horses, sheep, and many other things, the marvellousnesse whereof this geographer being not able to comprehend, he saies: 'Hæc saxa, hominum, camelorum pecorumque cæterarumque rerum formas referentia, Horda populi gregis pascentes armentaq. fuit: quæ stupenda quadam metamorphosi repentè in saxa riguit, priori parte nullâ in parte diminutâ.' And then, to make the story pass for a truth, he addes: 'Evenit hoc prodigium, annis circiter 300 retro elapsis.'"—*Guffarel.*

Fossil Birds.—The reference at p. 421 for the "head of an owl," in the 32nd line, should be to Pl. XXIV. fig. 1; and the reference at p. 422, line 30, "copied in Pl. XXII. fig. 2, *nobis*," should be omitted. The figure will be given in the next volume. The reference for Buttner's figure of a nest, in the last line of p. 423, should be "Pl. XXIII. fig. 3, *nobis*." The printers have made a presumed emendation at p. 424, after the revises left me for press, which alters my meaning entirely. The prefix "un-" at that page, in line 15, has been in this way put to the word "fortunate." I wish the word to be read as I wrote it, as I do conscientiously think it *fortunate* that we have not been troubled with more of these dendritic markings and fanciful resemblances. On the same page, in line 21, *for* "Fig. 3" *read* "Fig. 2," in reference to Hermann's "head of a goose."

PACHYRHIZODUS GLYPHODON.—The specimen described in Mr. Blake's article, at p. 133, is figured by Mr. Mackie in Pl. XXI.

MISCELLANEOUS NOTICES.

The 'Canadian Naturalist and Geologist' for February contains the first of Dr. Dawson's admirable papers on "Air-Breathers of the Coal Period of Nova Scotia," which are continued through the four consecutive numbers, and have since been published in a separate form. This number also contains papers "On the Gold Mines of Canada and the manner of working them;" "On the Parallelism of the Quebec Group with the Llandeilo of England and Australia and with the Chazy and Calciferous Formations," by Mr. E. Billings; by the same author, a "Description of a New Species of Harpes (*H. Dentoni*) from the Trenton Limestone, Ottawa," and "On the Internal Spiral Coils of the Genus Cyrtina," a new species, *C. euphemia*, being described. The April number contains a "Description of a new Trilobite from the Quebec Group" (*Olenus? Logani*), by Mr. T. Devine; "On the Antiquity of Man,"—a review of Lyell's 'Geological Evidences' and Wilson's 'Prehistoric Man;' "On the Remains of Fossil Elephants found in Canada," by Mr. E. Billings. The remains of the elephant now in the Canadian Geological Museum were found in 1852, at Burlington Heights, near Hamilton, at the western extremity of Lake Ontario, about 40 feet beneath the surface, and 60 feet above the level of the lake. The workmen engaged in making an excavation on the line of the Great Western Railway first cut through 30 feet of stratified gravel, composed of small pebbles of limestone, and so strongly cemented that it could only be removed by blasting. Below this gravel there was met with a deposit of coarse sand, and in this the bones were discovered. The geological age of this deposit is not yet determined with certainty, but is supposed to be that of the well-known lake-ridges and terraces, which were apparently formed just after the close of the upper drift period, and either while the waters of the lake stood at a higher level than they do at present or perhaps while the basin of the lake formed an arm of the sea. The species is named *Euelephas Jacksoni* by Mr. Billings, who says that no remains of man or of his works have been found in the formation which holds the bones of the elephant in Canada. In allusion to the absence of human bones in the ancient river-drift of Europe, he says, "I may mention that for the last fifteen years I have been in the habit of examining the bottom of the Ottawa and other Canadian rivers every season, at the time of the lowest water, in search of fossils, and that, although I have seen the bones of almost all the species of land animals now living in the country, associated with innumerable works of man, I never yet found a human skull in any of these streams. I speak of the skull, because it is possible that some of the small bones may have been those of the human frame and not recognized as such by me. But as man is the only animal who removes the dead of his own species from the water and buries them on shore, thousands of years may elapse without a single skeleton being embedded in a fluviatile formation; and yet the same formation may be full of the traces of his existence, associated with abundant remains of contemporary animals."

The June number contains a paper "On the Superficial Geology of the Gaspé Peninsula," by Mr. Robert Bell, of the Canadian Geological Survey. The Gaspé peninsula embraces the region lying to the eastward of a line drawn across the country, from the head of the Bay of Chalem to about Matan, on the St. Lawrence, and measures a hundred and forty miles in length by seventy in breadth. The superficial accumulations of this district differ in their general character from those of the country to the west, one of the most remarkable points of difference being the absence of foreign boulders. Sir William Logan, the Director of the Geological Survey, contributes one "On the Rocks of the Quebec Group at Point Levis," being a letter, now illustrated by a map, addressed by him to M. Barrande, commenting on M. Jules Marcou's disputations respecting the Taconic rocks of Vermont and Canada. Mr. Sterry Hunt's excellent paper "On the Chemical and Mineralogical Relation of Metamorphic Rocks," read before the Dublin Geological Society on the 10th of April last, is reprinted from the 'Dublin Quarterly Journal,' in this number, as it is also in Silliman and Dana's 'American Journal,' for October. Mr. Billings also furnishes a "Description of a new species of *Phillipsia* (*P. Howi*) from the Lower Carboniferous rocks of Nova Scotia;" and Mr. T. Devine a "Description of a new Trilobite from the Quebec Group (*Menocephalus Salteri*)."

The number for August contains "Observations on the Geology of St. John County, New Brunswick," by Mr. G. F. Matthew, with maps and sections; the rocks in the vicinity of St. John being New Red Sandstone, Carboniferous, Mispeck group, Little River group, Bloomsbury group, St. John's group, Coldbrook group, and the Portland group. There is also the first part of a paper of much interest "On the Origin of Eruptive and Primary Rocks," by Mr. Thomas Macfarlane. This gentleman has, on a previous occasion, published in the same periodical (vol. vii.) a series of papers describing the primitive formations of Norway, and comparing them with their Canadian equivalents. In those essays he abstained altogether from attempting to explain the various phenomena described, although he subsequently appended to them the translation of a chapter from Naumann's 'Lehrbuch der Geognosie,' in which the views entertained by geologists on the subject are stated. One of these theories hitherto most generally adopted supposes the primitive or primary rocks to have resulted from the alteration or metamorphism of sedimentary strata; another supposes them, in part at least, to represent the first solidified crust of our planet. Although these opposing theories might with justice be termed respectively the aqueous or metamorphic theory and the igneous theory, such names must not be regarded as having connection with the old theories of the Neptunists or Plutonists. Indeed, instead of there being any analogy with the old controversy, Hutton himself was the founder of the Plutonic school of former days, and the originator of the theory at present in favour, of the aqueous origin of the primary stratified rocks. On the other hand, it is scarcely possible to say who was the author of the igneous, although the writings in which it was propounded are of comparatively recent date. Mr. Macfarlane names Sir Henry De la Beche amongst its earliest supporters, and quotes the following passage from the 'Report on the Geology of Cornwall:'—"If we consider our planet as a cooling mass of matter, the present condition of its surface being chiefly due to such a loss of its original heat by long-continued radiation into the surrounding space, that from having been wholly gaseous, then fluid and gaseous, and subsequently solid, fluid, and gaseous, the surface at last became so reduced in temperature, and so little affected by the remaining internal heat, as to have its temperature chiefly regulated by the sun, there must have been a time when solid rock was first formed, and also a time when heated fluids rested upon it. The latter would be conditions highly favourable to the production of crystalline substances, and the state of the earth's surface would then be so totally different from that which now exists, that mineral matter, even abraded from any part of the earth's crust which may have been solid, would be placed under very different conditions at different periods. We could scarcely expect that there would not be a mass of crystalline rocks produced at first, which, however they may vary in minor points, should still preserve a general character and aspect, the result of the first changes of fluid into solid matter, crystalline and subcrystalline substances prevailing, intermingled with detrital portions of the same substances, abraded by the movements of the heated and first formed aqueous fluids." Although the language is somewhat indefinite, the igneous theory is shadowed forth in it, and this quotation may be considered as the text of Mr. Macfarlane's present Essay, in which he maintains that there is every appearance of reason for considering that the primitive Gneiss formation constitutes the first solidified crust of the originally-fused globe, and that the crystalline and subcrystalline rocks of the Primitive Slate formation are the products of a peculiar transition period, during which aqueous fluids gradually accumulated on the surface, and the latter attained a temperature approaching somewhat to that of the present day. This number also contains a short but able article by Mr. T. Sterry Hunt, "On the Earth's Climate in Palæozoic Times." Referring to our own Tyndall's wonderful experiments on the relation of gases and vapours to radiant heat, he shows their important bearing upon the temperature of the earth in former geological periods. Aqueous vapour, like a covering of glass, allows the sun's rays to reach the earth, but prevents, to a great extent, the loss by radiation of the heat thus communicated:—"When however the supply of heat from the sun is interrupted during long nights, the radiation which goes on into space causes the precipitation of a great part of the watery vapour from the air, and the earth, thus deprived of this protecting shield, becomes more and more rapidly cooled. If now we could suppose the atmosphere to be mingled with some permanent gas, which should possess an absorptive power like that of the vapour of water, this cooling process would be in a great measure arrested, and an effect would be produced similar to that of a screen of glass; which keeps up the temperature directly beneath it by preventing the escape of radiant heat, and indirectly by hindering the condensation of the aqueous vapour in the air confined beneath. Now we have only to bear in mind that there are the best of reasons for believing that during the earlier geological periods, all the carbon since deposited in the forms of limestone and of mineral coal existed in the atmosphere in the state of carbonic acid, and we see at once an agency which must have aided greatly to produce the elevated temperature that prevailed at the earth's surface in former geological periods. Without doubt, the great extent of sea, and the absence or rarity of high mountains, contributed much towards the mild climate of the Carboniferous age, for example, when a vegetation as luxuriant as that now found in the tropics flourished within the frigid zones; but to these causes must be added the influence of the whole of the carbon which was afterwards condensed in the form of coal and carbonate of lime, and which then existed in the condition of a transparent and permanent gas, mingled with the atmosphere surrounding the earth, and protecting it like a dome of glass. To this effect of carbonic acid it is possible that other gases may have contributed. The ozone, which is mingled with the oxygen set free from growing plants, and the marsh gas, which is now evolved from decomposing vegetation under conditions similar to those then presented by the coal-fields, may, by their great absorptive power, have very well aided to maintain at the earth's surface that high temperature the cause of which has been one of the enigmas of geology."

REVIEWS.

The Geology of the Country round Liverpool. By Geo. H. Morton, F.G.S.

Towards the close of 1861 a lecture was delivered to the Liverpool Naturalists' Field Club by the author, "On the Geology of the Country round Liverpool," which the Council of that Institution at once decided to publish. Since that period the author has re-surveyed and confirmed his original investigations, and otherwise matured and improved his work for presentation to the public. Ten years ago the subdivisions and superposition of the Triassic rocks in this district had not been determined, although Mr. Cunningham had as early as 1838 made known the occurrence of fossil footprints in the strata of the Storeton quarries; and it was not until Mr. Hull, who had then just completed his examination of the district for the Government Geological Survey, read a paper on the results of his labours before the British Association in 1854, that the details of these important beds were published. The book before us gives a concise and admirably clear account of the Liverpool district, commencing with the physical features of the country and the geological systems and formations exhibited to obtain it. These consist of the coal-measures, and Trias, and Pleistocene deposits, including boulder-clay, and submarine forests. The faults, denudations of the beds, and general geological history of the district, are also treated with accuracy and perspicuity of description. The numerous plates and woodcuts give well-selected examples of fossils and geological and physical phenomena. These include a view of the submarine forest of Leasowe at Dove Point, sections from the river Dee to Hayton, of the strata round Liverpool, through the coal-measures at Prescot, of the Lower Soft Red and Variegated Sandstone at Toxeth Park; of the pebble-beds at Eastham, through Fairbrick and Bidston Hills, showing the junction of the Upper Soft Red and Variegated Sandstone with the overlying Keuper Sandstone, of the Keuper at Liverpool and Wirral, of the strata along the three railway tunnels under the town, through the Lower Keuper at Storeton, across Wallasey Pool showing the submarine forest bed, along the Cheshire coast, from the lighthouse, Dove Point, Leasowe; and plates of the footprints of the *Cheirotherium*, *Rhynchosaurus*, and other fossils. The accounts of the post-glacial deposits are exceedingly interesting. The elevated ridges of sandstone traversing the district from north to south are generally free from drift, while the depth of the intervening valleys had been diminished by thick accumulation. The river Mersey occupies what was once the deepest of these valleys. From his examination of the shores, Mr. Morton considers the position of the rocks to be naturally low, and that though there have been promontories of rock at Dingle, New Brighton, and Eastham, as also of boulder-clay at Egremont and other places, these never extended any great distance. In most places the land slopes gradually towards the water, from which Mr. Morton concludes that a wide low valley existed at the end of the glacial epoch, and considers his conclusion confirmed by the existence of the submarine forest beds so frequently described by authors. The sections and strata prove, he thinks, that a subsidence of about fifty feet has taken place, there being several successive old forests or land surfaces, with silt between the oldest of them, overlying the boulder-clay. Along the coast from Crosby to Liverpool there are indications of the "forest-bed" which dips considerably in the valley of the Mersey, being thirty-five feet below high-water mark at the North Docks, near Bootle, where the section in descending order is—Sand, Blue Silt, Peat, or Forest-bed resting on sandstone. In 1829, a section was exposed in excavating at the Old Dock and gave

	High-water mark.
19 feet	Water.
3 feet	Dock Silt.
	White Sand.
6 feet	Blue Silt.
1 foot	Peat or Forest bed, with trunks of trees.
10 feet	Blue Silt, with stags' horns.
1 foot	Peat or Forest-bed, with trunks of trees.
	= 40 feet.
	SANDSTONE.

Other sections are given, some of which may still be visited. The whole area has now been converted into docks, it being during their construction that the opportunities for examination occurred, for ten years ago vessels sailed over the place, and now are moored in deep water there. It will be thus seen, Mr. Morton says, "that the pool occupies an ancient valley, the bottom and sloping sides of which were covered with trees." "The valley ofttimes became filled with water, and a deposit of mud formed over the bed of the pool, ten feet thick in the middle, and gradually thinning off at the sides;" "originally the submarine forest bed at the bottom of the valley would have been connected with the present surface of the land, but the continuation has been broken away by denudation along the sides of the pool." "The trees grew immediately above the boulder-clay, their roots and two or three feet of their trunks remaining *in situ* until torn up by the excavators." In the silt over the forest-bed a human skull and bones, incrusted with zoophytes and barnacles, were found by Mr. T. J. Moore, the Curator of the Liverpool Museum, and described by him in the tenth volume of the 'Transactions of the Historic Society of Lancashire and Cheshire.' Amongst the mammalian remains were bones and horns of *Bos primigenius*, *B. longifrons*, *Cervus elaphus*, and rib-bones of a cetacean. The Dove Point portion is very interesting, and the forest-bed may there be examined,—the old land-surfaces one over the other "indicating pauses in the subsidence, and each covered by accumulations of silt deposited during the gradual sinking of the land." The lowest forest-bed here is eight feet below the level of an ordinary spring tide. Approaching the embankment from Dove Point, the two lower forest-beds gradually amalgamate, and then are both merged into one, the three feet of intervening silt having entirely thinned out. "The surface of the boulder-clay upon which the lowest bed rests at Dove Point forms a depression; a gradual subsidence seems to have caused an eruption of the sea over the low-lying land, which then silted up the hollow; and a new forest, of more noble growth than the former one succeeded. This forest was afterwards destroyed, though hundreds of the roots and small portions of the trunks of trees still remain exposed on the shore. On the old land-surface, but not below it, have been found implements, ornaments, and coins of Roman, Saxon, and early English manufacture. Another bed of silt—a bluish mud—next occurs; then a bed of peat which, though it may be co-ordinated with the present surface, where not covered by drift sand, shows clear evidence of having been subject to inundations, for there is a bed of black sandy earth above it, containing, in addition to the common shells of the district, teeth of the ox, and the leaves and twigs of trees, being a comparatively recent deposit." The reason why Mr. Morton infers a subsidence of the whole area to the extent of nearly fifty feet, is that when the old land-surface beneath the Custom House, now above forty feet below high-water mark, was covered with vegetation, it must have been sufficiently above the sea-level to have afforded the necessary drainage for the growth of trees. "The most important of these changes,—the origin of the river Mersey by the irruption of the sea, in consequence of the subsidence of the land,—was probably before the occupation of Britain by the Romans; the subsidence of the old forest-beds of Leasowe, Dove Point, and Formby, was no doubt of much more recent date, certainly within the historical period."

Catalogue of Geological Collections, etc. By J. R. Gregory. 1863.

We have received one of Mr. Gregory's Catalogues of Collections of Geology and Mineralogy, Specimens, etc., on sale at his establishment in Golden Square. It contains, among other items, a long list of casts of rare and unique fossils from various museums and other collections, as also a useful list of geological books, periodicals, maps, and diagrams, models of crystals, and other objects. This Catalogue has, moreover, the advantage of being illustrated with eight tolerably good photographs of specimens, cabinets, and other desiderata, which will be found very useful by those who are about to commence the studies of geology and mineralogy, as well as to those who wish to add to their collections. Mr. Gregory's collections can with confidence be recommended, especially his elementary and educational series, for which he obtained a prize medal at last year's International Exhibition.

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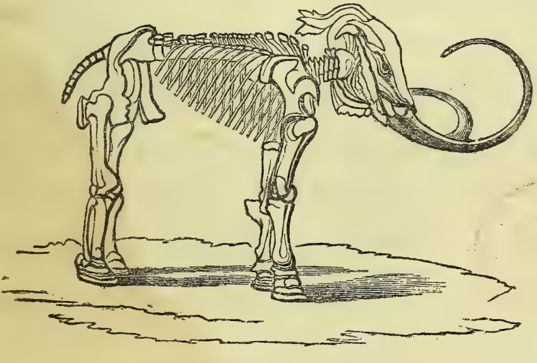

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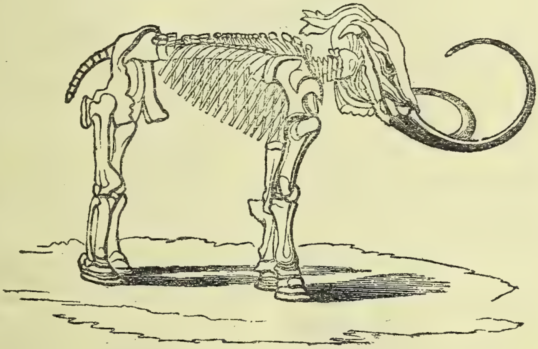

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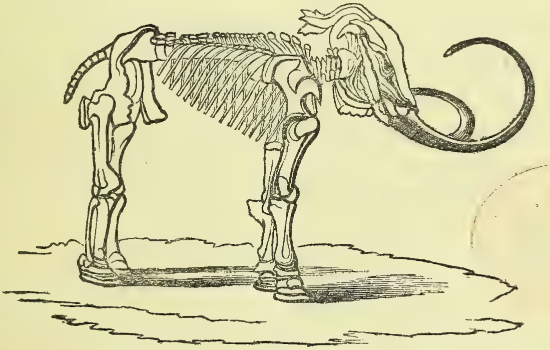

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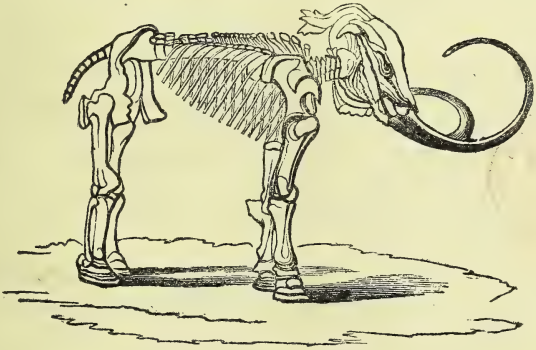

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The Canadian Naturalist and Geologist. Vol. vii. No. 5.

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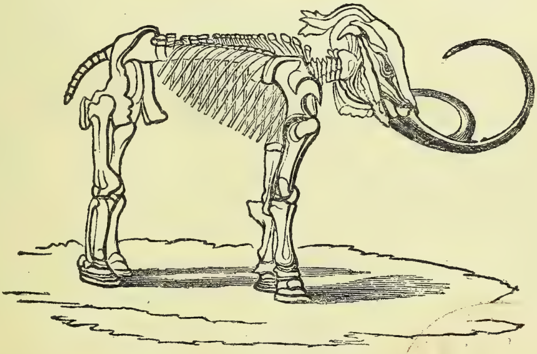

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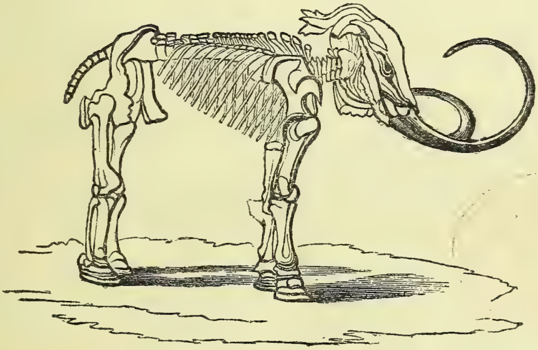

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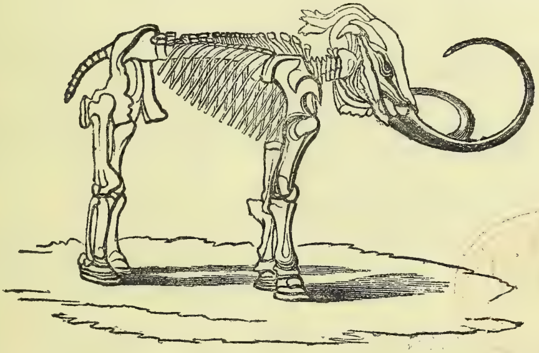

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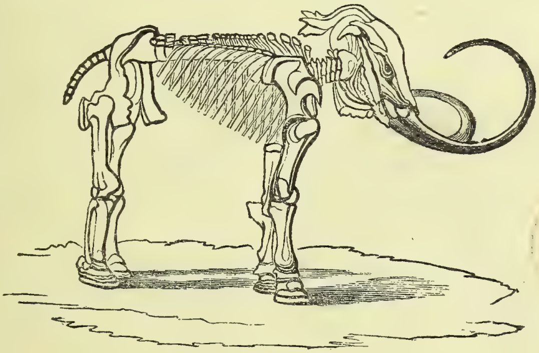

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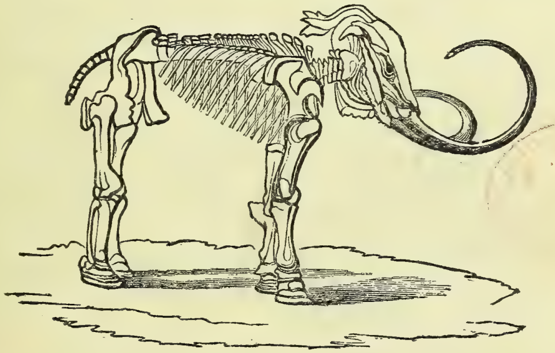

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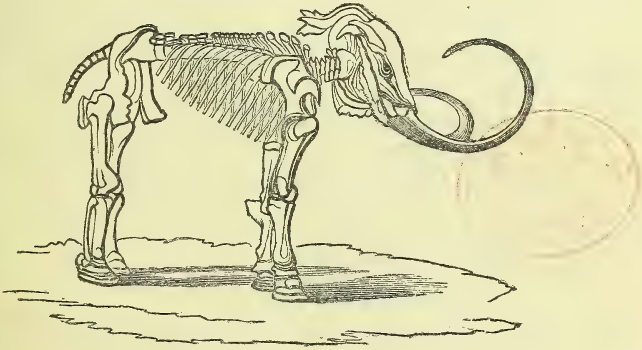

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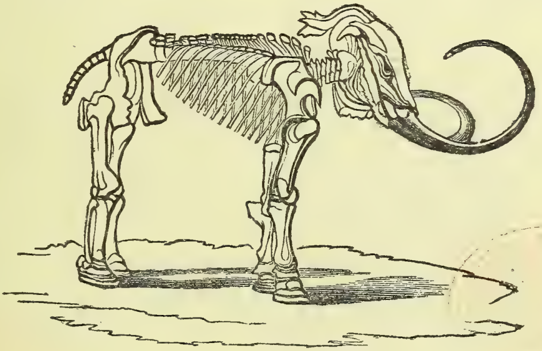

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The Geology of the Country around Liverpool. By George H. Morton, F.G.S. Revised Edition. Liverpool: Smith. 1863.

Abstracts of the Proceedings of the Liverpool Geological Society for 1861–2 and 1862–3. Liverpool: Tinling. 1863.

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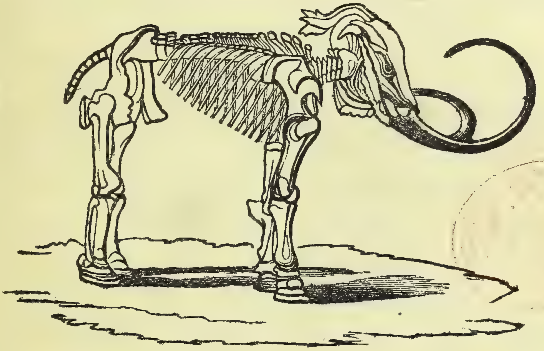

EDITED BY S. J. MACKIE, F.G.S., F.S.A.

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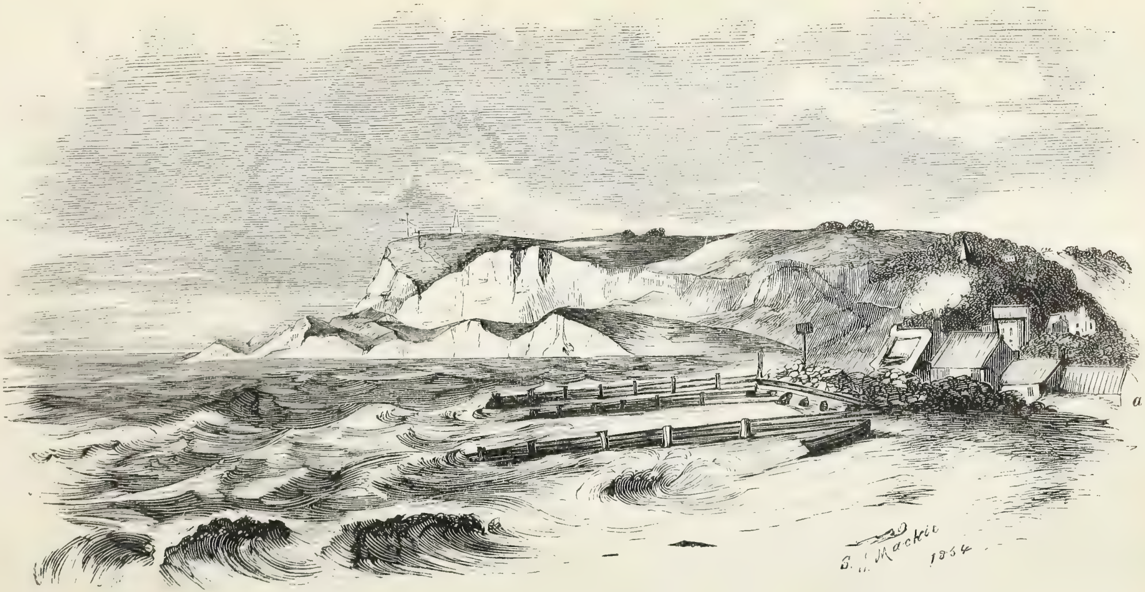

VIEW OF CAP-LA-HÊVE, FROM THE BEACH AT FRASCATI'S.

a. Shell-Sand Cliff at the back of kilns.

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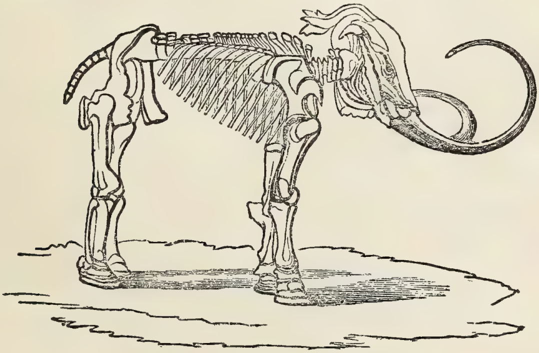
OF

GEOLOGY.

EDITED BY S. J. MACKIE, F.G.S., F.S.A.



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PREFACE.

'THE GEOLOGIST,' at which I have laboured with assiduity and pleasure for more than six years, is brought unexpectedly to a close, with only half the quantity of matter usually devoted to a volume. A new geological magazine is announced, and having received an intimation from my publishers that to continue 'The Geologist' in rivalry with it would be attended with anxiety, and perhaps with loss, I have decided to retire from the field rather than take part in a contest that might prove injurious to both.

To give up this monthly intercourse with so many friends at home and abroad is, naturally enough, a source of regret to me, if not of pain. I labour, however, neither to gratify vanity nor for gain. The honest wish of spreading and advancing knowledge, and of giving free scope to the expression of geological theories and criticism, has been my motive for maintaining this periodical, and I may with truth assert that, during the period of its publication, it has been a means of free intercourse among all classes of geologists. To its pages it has been my pride that ALL should, fairly and freely, have admission.

My duties are done; and in for ever closing this work I will but add, that had there been any option left with me I should have preferred to have completed this volume in full to the end of the year. There are, however, stronger reasons than I can control for closing it at once. With all my numerous friends I beg, however, to remain in personal correspondence; while the *new* works I hope to project will soon put me again in open communication with the world, and will, I trust, prove not merely my desire but my capacity to supply useful materials for the labours of others, and to do something myself also for the advance of a very imperfect but very noble science.

There is one labour—the first part of the first instalment of which will appear, I believe, on the 1st of July—my projected 'Illustrated Catalogue of British Fossils,' for which I hope to obtain *very extensive support.* The printing of the first portion, complete in itself, 'An Illustrated Catalogue of British Fossil Sponges,' has already been commenced, and in it the original figures, descriptions, and bibliography of all the described British fossil species will be given, with original notices of those new kinds which have already come to my knowledge, or may hereafter do so before the completion of the volume. As this work will be exceedingly full, it will entail a very heavy outlay on the publisher, not to be compensated, unless those geologists, who are not sponge-collectors, come freely to its support, in the faith that the success of this gigantic undertaking can only be accomplished by mutual help, if ultimately every department of British Palæontology is to receive similar illustration.

All but my last words are penned; I devote them to my best wishes for the welfare of all my friends.

S. J. MACKIE.

27*th May*, 1864.

THE GEOLOGIST.

JANUARY 1864.

ON THE EARTH'S CLIMATE IN ANCIENT TIMES.

By the Editor.

For some time past we have been drawing attention to some of the dicta of Geology, which appear to have a less solid foundation than they should have to authorize the positive manner in which they have been enunciated. Similar doubts on some points would appear not to be absent from other minds. Mr. Page has just issued a little work reviewing the state of the popular doctrines of our science, and Mr. Sterry Hunt has appropriated to the explanation of the higher Palæozoic climate Dr. Tyndall's memorable researches on the relations of gases and vapours to radiant heat. Heat, from whatever source it may proceed, passes through hydrogen, oxygen, and nitrogen gases and *dry* air, with nearly the same facility as through a vacuum, and these gases are thus to radiant heat what rock-salt is amongst solids. Glass and some other substances which are readily permeable to light and to solar heat, offer, as is well known, great obstacles to the passage of radiant heat from non-luminous bodies, and many vapours and gases have a similar effect in intercepting the heat from such sources. Thus, for a vacuum the absorption of heat from a body at 212° Fahr. is represented by 0, that by dry air as 1, while the absorption by an atmosphere of carbonic acid gas is 90; by one of marsh-gas, 403; by olefiant gas, 970; and by ammonia, 1195. Olefiant gas at 1 inch tension produces an absorption of 90°, and carbonic acid gas in the same state, an absorption of 5·6. The small quantities of ozone present in electrolytic oxygen were found to raise its absorptive power from 1 to 85, and even to 136; and watery vapour present in the air at ordinary temperatures produces an absorption of heat represented by 70 or 80. Air saturated with moisture at the ordinary temperature absorbs more than 5-100ths of the heat radiated from a metallic vessel filled with boiling water; and Tyndall calculates that of the heat radiated from the earth's surface, warmed by the sun's rays, one-tenth is intercepted by the aqueous vapour within 10 feet of the surface. The influence of moist air upon the climate of the globe is like that of a covering of glass,—it allows the sun's rays to reach the earth, but prevents to a great extent the loss by radiation of the heat thus communicated. During the long nights, however, the radiation which goes on into space causes the precipitation of a great part of the watery vapour of the air; and the earth, deprived of its protecting shield, becomes rapidly cooled. "If now," says Mr. Hunt, "we could suppose the atmosphere to be mingled with some permanent gas, which should possess an absorptive power like the vapour of water, this cooling process would be in a great measure arrested, and an effect would be produced similar to that of a screen of glass, which keeps in the temperature beneath it directly by preventing the escape of radiant heat, and indirectly by hindering the condensation of the aqueous vapour in the air beneath." Such a heat-absorbing gas might have existed, and, if geologists are right in their old notions about the abundance of carbonic acid gas in the days of the luxuriant coal-plants, did so; and Mr. Hunt seizes on this idea at once, and considers there are "the best of reasons for believing that during the earlier geological periods all of the carbon since deposited in the forms of limestone and of mineral coal existed in the atmosphere in the state of carbonic acid;" and he also considers other gases may have aided. "The ozone which is mingled with the oxygen set free by growing plants, and the marsh-gas which is now evolved from decomposing vegetation under conditions similar to those then presented by the coal-fields, may by their very great absorptive power have very well aided to maintain on the earth's surface that high temperature, the cause of which has been one of the enigmas of geology."

So far, very good; Mr. Hunt seemingly prefers carbonic acid in the air to the supposititious molten mass inside our globe. If there were a former higher climatal temperature of our planet, and such abundance of free carbonic acid in our atmosphere, doubtless all would happen just as Mr. Hunt indicates. But was there such an amount of free carbonic acid? and if so, whence did it come? Carbonic acid one would regard as the result of animal or igneous combustion. We could scarcely derive it from the piscine and mollusk life of the early geological life-periods; nor is it a bit clearer that there were any really igneous causes at work to produce it in such volumes. We would rather regard it as the resultant from the undoing of something else; if so, it was probably generated continuously, not in volumes. In nature too little remains free for any length of time. Length of time, with small quantities of carbonic acid, would accomplish the same result for vegetation as large quantities and very rapid action; and we have no right to conclude that the Coal period was not a long period. Moreover, we have no experiments to teach us that plants grow more rapidly and solidly in an abundance of carbonic acid than in purer air with only a slight amount of carbon in it. The *luxuriance* of vegetation is synonymous with *fixation* of *carbon*, and there is much to make us think that this takes place more freely and perfectly in proportion to the intensity of light and the purity of the air. Is it not the sunshine, and not the volume of carbon, that is the cause of luxuriance?

Mr. Hunt appends to his paper a notice of an article by the late Major E. B. Hunt, of the United States Engineers, "On Terrestrial Thermotics," published in 1849, in the Proceedings of the American Association, in which the Major argues that the temperature of the earth's surface increases with the barometric column, and that the atmospheric mass must have been greater in the earlier geological periods by the amount of carbon and carbonic acid since extracted from it, and that therefore the general temperature of the earth's surface must have been higher. To this effect of the carbonic acid Professor Dana adds the suggestion that the excess of moisture in the Carboniferous age would also have contributed to increase the weight of the atmosphere. Given the premises that the atmosphere consists of the residual gases remaining after the consolidation of the globe and the reduction to the liquid state of its seas and of the greater volumes of water evaporated from it in consequence of its previous supposed higher temperature, we might grant the values of these additions as considerable, especially the last. As it is, we admit the idea of Major Hunt is clever.

But a question or two may, however, be asked with advantage. We have, in former speculations, contested for a consideration of the possible interference of grand physical operations in effecting the alteration from remarkable former conditions of our planet. Let us glancingly turn our eyes now in the same direction. If the earth's orbital velocity and her rotation round her axis are due to some originating impulse, such as projectile force would be to a cannon ball, then the orbital velocity and the rotatory motion must have been higher in the early ages of our planet than at present, because if there be any friction opposed to motion in space that friction is an antagonistic power, that, no matter how slowly, would bring down and ultimately cancel the amount of the initial velocity, and reduce the object to a state of rest. If we consider the effects of a higher orbital velocity, we shall find it would give rise probably to a larger extent of orbit, and also to a higher rotatory motion. Now the higher rotatory motion, although it would give no more sunshine to the earth, would so far counteract the effects of night-radiation into space as that if the revolution were twice as quick, the effect of night-radiation would possibly not be half what it is, because the radiation being at a given rate for a given time, it could only attain half the diminution of temperature in half the time, and we know that the more *intense* the cold the more vegetation is *checked*. It might therefore happen that half our present intensity, never exceeded, might never bring vegetation to a standstill, and there might be a perpetual growing vegetation through both winter and summer under such favourable conditions. If the orbit were increased, these favourable conditions might, it may be seen at the first glance, be counteracted by the greater remoteness from the sun; but we have yet to learn that the nearer the sun the hotter would be our planet's general climate, or the further away greater in proportion the diminution of light. Is light dependent on the density of our atmosphere, and does it travel on as simple motion in the ethereal realms beyond our atmosphere? Is it the friction of waves of motion through our air that gives to light its luminosity? The sunlight falling on Neptune must be powerful, for the reflected beams from that far distant planet to reach us as definitely as they do in our powerful telescopes? And I do not know that the light from Jupiter is less intense than the light from our moon, quantity for quantity. But I do not want to take this subject away from the immediate bearings it may have on the former temperature of our planet.

If the light and heat of sunshine be due to the frictional resistance of the earth's atmosphere to the waves of motion proceeding from the sun's combustion or incandescence, the thicker the atmospheric stratum round a planet and the denser its condition, and the bigger the planet and the more remote its position from the sun, the denser it would be,—the greater would be the amount of heat and light derived from the passage of the sunshine through it. In this way it might happen that the distant planets, having enormous atmospheres, may be better lighted up and warmed than we have been in the habit of regarding them. It is difficult to conceive, moreover, that orbital velocity is not productive of some amount of heat in our atmosphere by friction ; and this in the larger orbits, where the rate of the planet is higher, must be greater in amount, and proportionate to the speed and size of the moving object. If the carbonic acid has been consolidated out of our atmosphere, oxygen has been extracted also; and if we are to regard the bulk of our atmosphere as diminished by the chemical combinations of its gases with terrestrial solids during the progress of vast ages, we may regard this diminution of its bulk as gigantic,—perhaps as fully a half-part since the commencement of the Palæozoic period.

By these remarks we are not ignoring the sagacity of Mr. Sterry Hunt's suggestions; they are very valuable and in the right direction. Our object is to submit that there may be cosmical reasons for great changes of climatal temperature, and others besides those we have hinted at; but it would be futile to look to cosmical causes unless we were prepared to admit the wonderful remoteness of the early periods geology has made known to us,—but which, after all, are only on the very threshold and entrance of the research into the great past existence of our planet that went before the earliest traces of its history our science has yet detected.

Some day we shall inquire what foundation there really is for the supposed former higher temperature of our earth at all ? Perhaps we shall not find as much reason for the doctrine as some people suppose.

THREE DAYS AT FARRINGDON.—POSITION OF SPONGE-GRAVEL.

By C. J. A. Meyer.

Early in September of the present year, I accompanied my friend Mr. C. Evans in a short excursion to Farringdon, with a view to examining the well-known "Sponge-gravel" pits of Little Coxwell ;

our intentions being, besides collecting fossils, to trace, if possible, some positive connection, or otherwise, between these reputed Upper Cretaceous Sponge-gravels and the acknowledged *Lower Greensand* deposits of Furze Hill and Badbury Hill.

Taking up our quarters at Farringdon, we first visited the Sponge-gravel pit near the Windmill public-house at Little Coxwell, where we found a splendid section of the gravel exposed (see section 4), and in a few hours had collected a good supply of fossils;—dip of beds E. by N. 10°, resting, in part at least, upon Kimmeridge clay. Next day we went to Furze Hill, and found near the top of the hill the ironstone concretions described by Mr. Godwin-Austen (Quar. Journ. Geol. Soc., vol. vi. p. 456), containing numerous fossils, all of them, I believe, of Lower Greensand age. These concretions, for the most part, lie scattered about on or near the surface. In one place, however, we found a small section exposed, where the concretions occurred in position, imbedded in light-coloured sand. About fifteen feet lower down the hill, we found the same light-coloured sand, alternating with clay in thin layers, without concretions, and apparently unfossiliferous.

In returning towards Farringdon by a pathway across some fields, and when about a mile east of Little Coxwell, we came to a gravel-pit of large size, the gravel of which struck us at once as being unlike that of the Windmill pit, the colour being very much darker, and the composition of the beds somewhat different. And here we presently observed an interesting fact, which seems to have hitherto escaped notice, viz. that this dark-coloured gravel (which, from its appearance, I shall call "red-gravel") *rests unconformably upon* the light-coloured "Sponge-gravel" of the Windmill pit,—the Sponge-gravel, as before observed, dipping E. by N., the Red-gravel W. by S. at a slight angle, the line between the two beds being sharply defined. The section exposed in the deepest part of the pit gave a thickness of about twenty feet to the Red-gravel, with the addition of six feet of Sponge-gravel (visible) beneath (see section 3). The composition of the Red-gravel we found to differ from that of the Sponge-gravel, in the scarcity of Sponges and the greater comparative abundance of Bryozoa.

As this pit (which, for distinction, I shall call East pit) is scarcely half a mile distant from the Windmill pit, both of them being on much the same level,—occupying, in fact, opposite sides of a flattened ridge of ground which extends from Furze Hill towards Farringdon, —a cross section between the two pits must be somewhat as is shown in the section, Pl. I. Fig. 1:—

Our next excursion was to Badbury Hill. In a small pit near the roadside, on the west slope of the hill, and at about fifty feet from the top, we found a section exposed, which was to me by far the most interesting one I had yet seen. This section was as follows:—

+ Light-coloured and ferruginous sand, with slabs and fragments of chert, apparently the débris of higher beds . . . . . . 14 feet.

a. Fine ash-coloured sand, *regularly stratified*, very like the sands with clay beneath the ironstone of Furze Hill	4 feet.
b. Dark-brown and ferruginous sand, with a mixture of small pebbles, Bryozoa, Terebratulæ, etc., regularly stratified	4 feet.
c. Ditto, ditto, with two or more bands of hard calcareous concretions, each about eight inches in thickness	5 feet.

This last was the lowest stratum exposed, but, from the appearance of the soil, the pebbly sands extended somewhat lower.

In the looser materials composing the strata *b*, *c*, we immediately recognized the upper portion of the Red-gravel of East pit, containing here, as there, *Rhynchonella nuciformis* in abundance, *R. latissima*, *R. depressa*, *Terebratella Menardi*, *Terebratula Tornacensis*, *T. depressa*, more rarely; and, in addition, a few specimens of *Terebratella oblonga*, Sow.

In the intermediate stone-beds, *c*, *T. oblonga* was not uncommon, associated more rarely with *R. depressa*, *T. Menardi*, *T. depressa*, and *T. Robertoni*, D'Arch. The stone also contained *Avicula Rauliniana*, D'Orb., *Pecten Rauliniana*, D'Orb., *P. orbicularis*, *Exogyra conica*, var., and *E. haliotoidea*,—shells which occur in the "Bargate Stone" and "Pebble-beds" of Godalming. In fact, except for the greater abundance of organic remains, this section agrees precisely with a section exposed in a quarry of the Lower Greensand near St. Katherine's Chapel, Guildford, where "pebble-beds" alternate, for a thickness of twenty feet or more, with layers of the "Bargate stone."

I was greatly pleased at finding *Terebratella oblonga* here in such comparative abundance, associated with *T. Menardi*, etc., as I had only met with a single specimen in the Sponge-gravel. Yet, what seemed to me to be of greater interest in this Badbury Hill section was the *upward* passage of the dark-coloured pebbly strata *b* (Red-gravel) into *a*,—thus, as it were, limiting the position of the Sponge-gravels within a definite vertical range; the fine sandy strata, *a*, underlying the ferruginous sands with chert and ironstone as well here as at Furze Hill and Farringdon Clump.

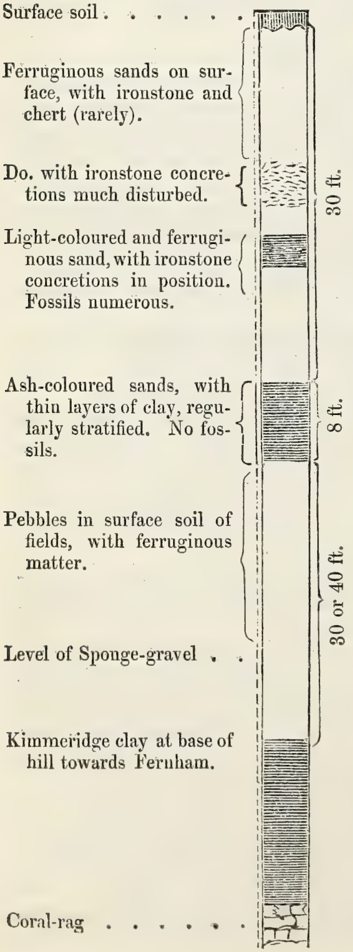
Our time being limited, we now returned towards Farringdon, revisiting the pits at Little Coxwell, and again examining the junction of the Sponge and Red-gravels in East pit.

From what I have now seen of the several sections in the neighbourhood, I can form but one opinion as to the position of the Sponge-gravels with relation to the surrounding deposits, viz. that the true "Sponge-gravel" of the Windmill-pit is unquestionably *the oldest of the Cretaceous deposits near Farringdon*, the strata exposed in the sections at East Pit and Badbury Hill (see sections 2, 3), forming, as nearly as possible, a continuous series; while at the same time there is no reason to doubt that the fossiliferous concretions capping Furze Hill are identical with the ironstone concretions which occur near the top of Badbury Hill, intermingled, here and there, with the cherty fragments. In offering so strong an opinion on this subject, I am, however, willing to confess, that had I not seen *the actual junc-*

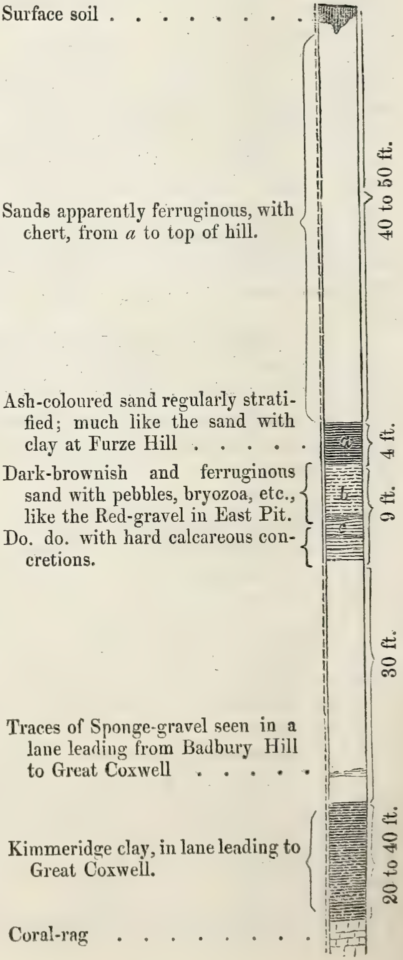
tion of the Sponge and Red gravels in East pit, and again met with the Red-gravel, in a slightly different form, near the top of Badbury Hill, I should not have ventured to assign any positive position to the true Sponge-gravel.

By what I gather from Mr. Sharpe's memoir 'On the Age of the Fossiliferous Sands and Gravels of Farringdon and its Neighbourhood' (Quar. Jour. Geol. Soc., vol. x. p. 176), the author of that paper was not aware of any real difference between the *Red* and the *Sponge*-gravels, and certainly not that they were distinct deposits, as is no doubt the case; nor does he seem to have himself examined the

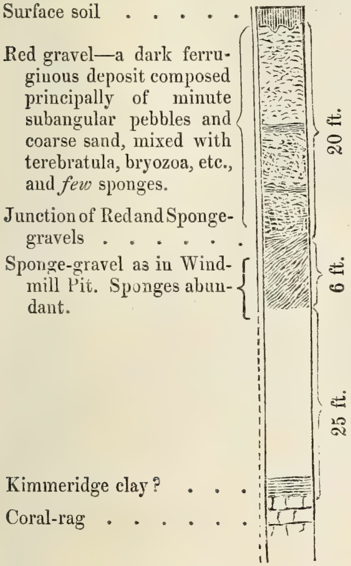
1. Section at Furze Hill.


Surface soil
Ferruginous sands on surface, with ironstone and chert (rarely).
Do. with ironstone concretions much disturbed.
Light-coloured and ferruginous sand, with ironstone concretions in position. Fossils numerous.
Ash-coloured sands, with thin layers of clay, regularly stratified. No fossils.
Pebbles in surface soil of fields, with ferruginous matter.
Level of Sponge-gravel
Kimmeridge clay at base of hill towards Fernham.
Coral-rag
30 ft.
8 ft.
30 or 40 ft.

2. Section at Badbury Hill.


Surface soil
Sands apparently ferruginous, with chert, from *a* to top of hill.
Ash-coloured sand regularly stratified; much like the sand with clay at Furze Hill
Dark-brownish and ferruginous sand with pebbles, bryozoa, etc., like the Red-gravel in East Pit.
Do. do. with hard calcareous concretions.
Traces of Sponge-gravel seen in a lane leading from Badbury Hill to Great Coxwell
Kimmeridge clay, in lane leading to Great Coxwell.
Coral-rag
a
b
c
40 to 50 ft.
4 ft.
9 ft.
30 ft.
20 to 40 ft.

3. Section at East Pit, Little Coxwell.


Surface soil . . . . .

Red gravel—a dark ferruginous deposit composed principally of minute subangular pebbles and coarse sand, mixed with terebratula, bryozoa, etc., and *few* sponges.

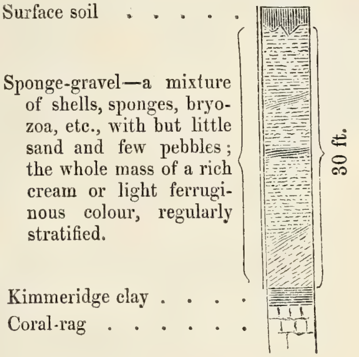
Junction of Red and Sponge-gravels . . . .

Sponge-gravel as in Windmill Pit. Sponges abundant.

Kimmeridge clay ? . . .

Coral-rag . . . . . .

4. Section at Windmill Pit, Little Coxwell.


Surface soil . . . . .

Sponge-gravel—a mixture of shells, sponges, bryozoa, etc., with but little sand and few pebbles; the whole mass of a rich cream or light ferruginous colour, regularly stratified.

Kimmeridge clay . . . .

Coral-rag . . . . . .

These sections are intended to exhibit the Farringdon deposits in their relative position; the measurements in those portions of the sections noted as *obscure* by the dotted line at the sides of the woodcuts must, however, be taken as merely approximate, as we had no means of ascertaining their real thickness.

section at Badbury Hill. Had he done so, he must have noticed the fact that the same forms of Brachiopoda, with the addition of *T. oblonga*, and the same species of Bryozoa occur there which are found in the Red-gravel of East pit; and noticing this, he could hardly have separated the "Sponge-gravels" so entirely from all the surrounding deposits as he ultimately appears to have done. In one very important particular Mr. Sharpe is surely wrong. In page 178 of the above-mentioned memoir, he describes the ironstone deposits of Furze Hill, and the Sponge-gravels, as forming "*two deposits on the same level, abutting against one another.*" Now my impression is that the lower layers of the ironstone of Furze Hill, where in position, are decidedly above the level even of the higher portion of the Sponge gravel; and I was at first somewhat at a loss to account for the fact, supposing that the ash-coloured sands which we found to underlie the ironstone on Furze Hill, formed a portion of the Kimmeridge clay, and not, as we afterwards found in the Badbury Hill section, a deposit resting upon the Red-gravel.

The accompanying sections, compiled, with Mr. Evans's assistance, from notes taken on the spot, the parts margined by the double lines being from exposed vertical sections, will show more fully my idea of the position of the various deposits; and it follows that if these views as to the position of the "Sponge-gravel" are correct, the question as to its age can hardly remain doubtful, all the authorities agreeing that the fossiliferous ironstone concretions of Furze Hill are unquestionably *Lower Greensand.* Even, however, were this not the case, I should have no hesitation in comparing the Red-gravel of the Badbury Hill section with the Lower Greensand "Pebble-beds" of the St. Katherine's Hill quarry, near Guildford, so very striking is the resemblance between the two deposits.

And it is no new idea thus to compare the Farringdon deposits to the sands and gravels of Devizes, Calne, etc., nor even to the pebble-beds of the L. G. S. of Surrey. In June, 1850, Mr. W. Cunnington called attention to the occurrence of most of the Farringdon Brachiopoda in the Lower Greensand of Seend, near Devizes (Quar. Jour. Geol. Soc. vol. vi. p. 453). Mr. Godwin-Austen repeatedly refers to these deposits as being of similar age (Quar. Jour. Geol. Soc. vol. vi. p. 455; and vol. xii. p. 69); and Mr. Sharpe himself admits the fact of their accordance to each other. In comparing these deposits, however, it is necessary to distinguish between the *two* gravel-beds of Farringdon, and this does not appear to have been hitherto done; for it is the Red-gravel, containing, as it does, nearly all the Brachiopoda which occur in the lower deposit, but very few of the Sponges, that has been met with at Seend, and *not* the Sponge-gravel; and it is the Red-gravel which accords best with the Lower Greensand "pebble-beds" of Surrey.

LIST OF BRACHIOPODA FROM FARRINGDON.

	Sponge Gravel, Windmill Pit.	Red Gravel of East Pit.	Red Gravel of Badbury Pit.	Bargate Stone of Godalming.	Pebble-beds of Godalming.	Lower Greensand, Shanklin.	Gault, Upper Greensand or Chalk of England.
	1	2	3	4	5	6	7
Lingula truncata, *Sow.*	×	...	...	...	...	× × ×	...
Thecidium Wetherellii, *Morris*	×	...	...	...	...	...	×
Terebratella Menardi, *Lam.*	× × ×	×	× ×	×	×	...	×
T. oblonga, *Sow.*	×	...	× ×	× ×	× × ×	...	× ?
Terebratula biplicata, *Brocchii*	× ?	...	...	...	...	× ?	× × ×
T. sella, *Sow.*	× ?	...	...	...	...	× ×	× ?
T. tornacensis, *var.*, D'Archiac	× × ×	×	× ×	×	× ?	×	...
T. depressa, *Lam.*	× ×	×	×	...	× ?	×	...
T. Robertoni, *D'Archiac*	×	× ?	× ?	× ?	× × ×?	× ?	...
T. tamarindus, *Sow.*	×	×	...	...	×	...	...
Rhynchonella latissima, *Sow.*	× ×	...	×	×	?	..	× ×
R. depressa, *Sow.*	× × ×	×	× ×	×	×	× ?	× ?
R. nuciformis, *Sow.*	× ×	× × ×	× ×	×	×	?	×
R. Gibbsiana, *Sow.*	×	...	...	...	×	× ×	...

N.B. × Denotes the occurrence of a species as *rare.*
× × As tolerably common.
× × × As abundant.

Although I have formed my *conclusions* as to the age of the Sponge-

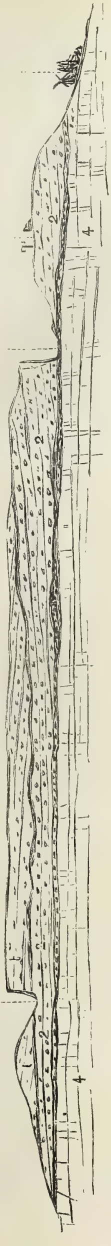


Fig. 1.

SECTION FROM FURZE HILL TO FARRINGDON.—1. Red Gravel. 2. Sponge Gravel. 3. Kimmeridge Clay. 4. Coral Rag.

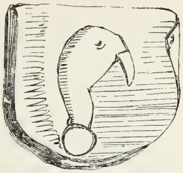


Fig. 2.

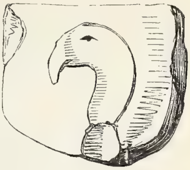


Fig. 3.

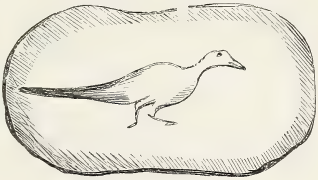


Fig. 8.

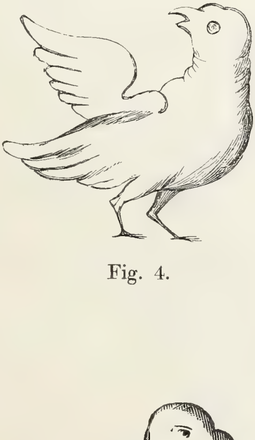


Fig. 4.

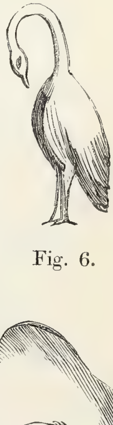


Fig. 6.

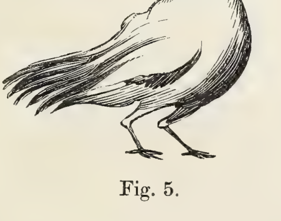


Fig. 5.

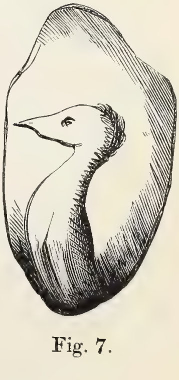


Fig. 7.

FOSSIL BIRDS.—Facsimiles from lesser Figs. 2, 3; from Kircher, Figs. 4 to 8.

gravels on geological rather than on palæontological evidence, the accompanying list of Farringdon Brachiopoda, from specimens which I have myself collected, may not be uninteresting. I regret that I cannot add a list of the small Bryozoa, etc., as several of the species are common alike to the Lower Greensand pebble-beds of Godalming and the Sponge-gravels.

In this Table, the columns 1, 2, 3 show the species of Brachiopoda met with by Mr. Evans and myself in our visit to the sponge-gravel pits. Col. 4, 5, 6, I have added, as showing instances of the occurrence of the same species in the Lower Greensand of Godalming and Shanklin, which have come under my own observation; and col. 7, as showing their recorded occurrence in British Cretaceous deposits of an age younger than that of the Lower Greensand. The absence in the Farringdon deposits of such *Upper Greensand* forms as *Terebratella pectita, Terebratulina striata, Kingena lima, T. ovata, T. biplicata, T. obtusa, Rhynchonella compressa, R. sulcata*, and *R. grasiana*, species which do not appear to be uncommon at Warminster and Cambridge, has long seemed to me to be a fact of much significance.

FOSSIL BIRDS.

By the Editor.

(*Continued from page* 455.)

Rozier says, in his 'Journal de Physique,' 1782, page 174, that "mention is made in the Catalogue of Davila of a tibia and of a beak imprinted on two different stones." If there be any other notice in Davila than the passages we have quoted, it has escaped our search.

In 1782, M. Robert de Paul de Lamanon gave, in the Abbé Rozier's 'Journal de Physique' (vol. xx. p. 174), an excellent summary of what was then known of Ornithic fossils. After noticing the accounts in Albertus Magnus and other old authors, he goes on to say in his 'Description de Divers Fossiles trouvés dans les carrières de Montmartre, près Paris, et vues générales sur la formation des Pierres gypseuses,'* "M. Rouelle, according to M. Darcet, found in the plaster quarries of Montmartre parts of a bird separated one from the other. I (Lamanon) have seen also in the Cabinet of Natural History of Bordeaux, some bones that it has been attempted to refer to birds; they were found by the Abbé Desbiey in the quarries of Léognan, which are at two leagues from this capital. We can only assert, however, that these isolated bones *may* have belonged to birds, on the ground that their medullary cavity is very large relatively to their thickness. No anatomist has determined what is the relation of this cavity to the osseous portion in the different classes of animals; it is even probable one could not establish any general rule in this respect, and that certain aquatic animals have bones as light and as delicate (déliés) as many birds. As to this, which has the beaks separated from the body, it is very easy to be deceived; and we know that the beaks of birds, as they were for a long time believed to be, in grey amber, have been recognized as the beaks of a cuttle-fish (sèche) or a calmar, since they have been better examined.

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* In the Abbé Rozier's 'Journal de Physique,' March, 1782, p. 174 *et seq.*

"But eliminating all that authors have so assigned through heightened imagination, there remain some facts about which no legitimate doubt is permissible, since the fine discovery that has been made of which I have to render an account. On the 2nd November of the past year (1781), M. Darcet made a lithological journey to Montmartre, and found in the hands of the workmen who worked at the plaster-quarries (plâtrières) a petrified bird, in the most beautiful conservation. We should not, perhaps, have had for a long time the complete proof of the existence of ornitholites, if this *savant* had not been that day at Montmartre, for the workmen destroy what they find, or sell to the first comer; and thus it is so much is lost to the progress of Natural History. M. Darcet is engaged at this time in important chemical labours, and has very kindly confided this petrifaction to me, and requested me to describe it.

"The cliff (butte) of Montmartre is elevated about 40 toises above the level of the Seine at Paris; the gypsum rock, of which it is chiefly composed, is there arranged in beds more or less distinct, more or less adherent one to another. We see at the line of their contact a band, which seems to contain a slightly ferruginous matter. If we separate these from each other, and observe their surfaces, we find them less brilliant (brillantes) than the interior of the stone; they are also of a lighter tint of red. Powder is used in working the quarries and to obtain the blocks, which are afterwards broken by blows of the hammer; it was in the interior of the stone, at more than 20 toises from the summit, and between two adherent beds (deux couches qui avoient entr'elles de l'adhérence) that the bird in question was found. The greatest part of its substance has followed the upper bed, and one sees the rest with the imprint of the whole in the lower bed. It is posed (posé) on its side; one of its wings extended, the other folded (repliée); the head is turned in such a manner that we see one eye, the under-part (dessous) of the beak and a part of the upper (dessus). Its position (situation) is natural, and there is not any transposition in the parts. It appears, then, that it has not been embedded (enseveli) alive, and that it did not perish in a catastrophe (dont ses ailes n'auroient pu le garantir), but that it fell at the bottom of tranquil water, which deposited in course of time the beds above it."*

As yet, however, bird-remains had been but little collected, and we find the celebrated Peter Camper, the discoverer of the famous *Mosasaurus*, of Maestricht, in a letter printed in the "Philosophical

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* Further details from Rozier and the figure from his Plate will be given in the stratigraphical considerations with the other gypsum fossils.

Transactions"* for 1786, writing about them in a very doubtful manner:—

"Dr. Michaels wrote me some time ago that the above-mentioned fragment in Mr. J. Hunter's collection belonged to a bird, which I could hardly believe, as I never had seen in any collection whatsoever, either in London, Paris, Brussels, Göttingen, Cassel, Brunswick, Hanover, or Berlin, nor in my own country, any fossil bone belonging to a bird. I know there is a small one described in the Abbé Rozier's 'Journal de Physique' for March, 1782, which is at present in the collection of M. d'Arcet, at Paris. I expect also from Montmartre a small leg of a petrified bird, but these are the only ones I have ever heard of; those of Stonefield, near Woodstock, being undoubtedly fishes. I think it is a curious circumstance worthy the attention of the curious, that no human bones, and of birds but very few, have hitherto been found in a petrified state belonging to the Old World."

Having now run through the more or less doubtful and apocryphal statements of the early naturalists and geologists, we may attempt to follow out a stratigraphical arrangement of the remainder of the mass of materials before us, giving the various discoveries and accounts at the same time as nearly as may in their proper sequence, and reserving for our concluding summary the comments, and any disputations of the ordinarily received opinions of geologists. We then take here the supposed earliest geological traces of birds; the footprints in the so-called Connecticut New Red Sandstone. We leave for the present the dispute as to the Trias being the correct period to which to assign those strata, for even if these Red Sandstone beds should really belong to the Jurassic series, the footprints they contain would still be the earliest traces of ornithic life we as yet possess.

The first specimen of the footmarks in the valley of the Connecticut river was ploughed up in South Hadley in 1802, by Pliny Moody, Esq., then a boy, before he went to college. This specimen, containing a row of fine tracks, was purchased by Dr. Dwight, of South Hadley, and is now in the Appleton Ichnological Cabinet (No. 16/2). So strikingly did these tracks resemble those of birds that they were familiarly spoken of as the tracks of "poultry" or of "Noah's Raven."†

It was not, however, until 1836, that any attempt was made to describe these tracks scientifically. The year previous some flagstones were obtained in Montague for the streets in Greenfield, by

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* Phil. Trans., vol. lxxvi., 1786, p. 451.

† Mr. Dexter Marsh, however, in a letter to Professor Silliman, in 1848, says, "You will recollect that the first specimen of fossil footprints of birds ever brought into public notice in this country (United States) was the slab I discovered among the flagging-stone, while laying the flagging-stone near my house, which Dr. Deane first described to President Hitchcock as the *footprints of birds*,"—from which statement it would seem that Mr. Marsh claims to be the first to notice these impressions, and Professor Hitchcock adds, in conversation with Mr. Wilson, "I understood him to claim the discovery." (Amer. Journal Science, vol. vi. new ser. p. 272.)

Mr. William Wilson, who observed impressions upon them, which he regarded as those of the "turkey tribe." They (*Tridentipes elegans*) were observed by the late Dr. James Deane, who sent casts of them to Professor Hitchcock, secured them for his cabinet and gave it as his opinion, from their form and succession, that they were made by birds. After visiting all the quarries, and discovering other and larger specimens, Professor Hitchcock gave a scientific description of seven species in 1836 in the 'American Journal of Science.' With a few eminent exceptions—Silliman, Buckland, Rogers, Emmons, etc.—his views were not adopted by scientific men. He continued, however, to explore, and from time to time to describe new species until, within six years, during which he laboured almost alone, the number of species amounted to thirty-two; and a general acquiescence was secured for the views he had advanced. The following bibliography will show by whom, when, and where the tracks—birds' and other tracks—have been described up to 1858.*

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Ornithicnites in Connecticut. In 'American Journal of Science,' vol. xxxi. p. 174. January, 1837. By E. Hitchcock.

Ornithicnites in Connecticut. By Professor B. Silliman. Op. cit. p. 165.

Fossil Footsteps in Sandstone and Grauwacke, with a general table. By E. Hitchcock. In 'American Journal of Science,' vol. xxxii. p. 174. July, 1837.

Newly Discovered Ichnolites at Middletown, Connecticut. By W. C. Redfield. In 'American Journal of Science,' vol. xxxiii. p. 201. January, 1838.

Note to Professor Conrad's Remarks on *Ornithichnites*. By Professor B. Silliman. In 'American Journal of Science,' vol. xxxv. p. 246. January, 1839.

Final Report on the Geology of Massachusetts. By E. Hitchcock. 62 quarto pages and 22 plates devoted to the footmarks, and 27 species described. Amherst, 1841.

Report by Professor H. D. Rogers, Lardner Vanuxem, R. C. Taylor, E. Emmons, and T. H. Conrad, on the *Ornithicnites*, or Footmarks of Extinct Birds, in the New Red Sandstone of Massachusetts and Connecticut, observed and described by Professor Hitchcock, of Amherst. In 'American Journal of Science,' vol. xli. p. 165. October, 1841.

Five New Species of Fossil Footmarks. By E. Hitchcock. Described in 'Transactions of American Association of Geologists and Naturalists,' vol. i. p. 254. 1842. 11 pages and 1 plate.

New Species of Footmark, with Rain-marks from Portland, Connecticut. By W. C. Redfield. In 'American Journal of Science,' vol. xliii. p. 172. October, 1842.

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* This account and the bibliography is taken in the main from Hitchcock's 'Report on the Sandstone of the Connecticut Valley, especially its Fowl Footmarks.' Boston, 1858.

Notice of Newly Discovered Fish-Beds and a Fossil Footmark in the Red Sandstone Formation of New Jersey. By W. M. C. Redfield. In 'American Journal of Science,' vol. xliv. p. 134. April, 1843.

On the Fossil *Footprints of Birds* and Impressions of Rain-drops in the Valley of the Connecticut. By Charles Lyell. In Quart. Journ. Geol. Soc. of London, vol. iii. no. 91. Also in 'American Journal of Science,' vol. xlv. p. 394.

Ornithichnites of the Connecticut River Sandstones and the Dinornis of New Zealand. By Professor B. Silliman. (Dr. Deane's correspondence with Dr. Mantell.) In 'American Journal of Science,' vol. xlv. p. 177. October, 1843.

On the Fossil Footmarks of Turner's Falls, Massachusetts. By James Deane, M.D. 5 pages and 2 plates. In 'American Journal of Science,' vol. xlvi. p. 73. April, 1844.

Report on Ichnolithology or Fossil Footmarks, with a Description of several New Species and the Coprolites of Birds from the Valley of the Connecticut River, and of a supposed Footmark from the Valley of the Hudson River. By E. Hitchcock. [Read before the Association of American Geologists and Naturalists at Washington, 11th May, 1844.] In 'American Journal of Science,' vol. xlvii. pp. 113 and 292. 32 pages and 2 plates.

On the Discovery of Fossil Footmarks. By James Deane, M.D. In 'American Journal of Science,' vol. xlvii. p. 381. 10 and 2 pages.

Rejoinder to the preceding Article. By E. Hitchcock. Op. cit. p. 390. 10 pages.

Answer to the Rejoinder of Professor Hitchcock. By J. Deane. Op. cit. p. 399. 10 and 3 pages.

Analysis of the Coprolites of Birds from the New Red Sandstone of the Connecticut. By Samuel L. Dana, LL.D. With remarks by E. Hitchcock. In 'American Journal of Science,' vol. xlviii. p. 46. 15 pages.

Extract of a Letter from Professor E. Hitchcock, embracing miscellaneous remarks upon Fossil Footmarks, etc., and a Letter from Professor Richard Owen, on the Great Bird-nests of New Holland. In 'American Journal of Science,' vol. xlviii. p. 61. April, 1845. 4 pages.

Description of Fossil Footprints in the New Red Sandstone of the Connecticut Valley. By James Deane, M.D. In 'American Journal of Science,' vol. xlviii. p. 158. April, 1845. 10 pages and 1 plate.

Fossil Footmarks found in the Strata of the Carboniferous Series in Westmoreland County, Pennsylvania. By Dr. T. A. King. In 'American Journal of Science,' vol. xlviii. pp. 217 and 343. April, 1845. 11 pages with woodcuts.

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Footprints. By Dr. J. A. King. In 'American Journal of Science,' vol. xlix. p. 206.

Fossil Footmarks and Raindrops. By James Deane, M.D. In 'American Journal of Science,' vol. xlix. p. 213. 3 pages.

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Notice of a Small Ornithicnite. By Professor C. B. Adams. In 'American Journal of Science,' vol. ii. new series, p. 215. November, 1846.

On the Evidence of Fossil Footprints of a Quadruped, allied to Cheirotherium, in the coal-strata of Pennsylvania. By Sir Charles Lyell. In 'American Journal of Science,' vol. iii. new series, p. 74. 6 pages. May, 1847.

Ornithicnites—Phalangial Impressions. By the Editors of 'American Journal of Science,' vol. iii. new series, p. 276.

Tracks of Alligators. Op. cit. p. 125. By the Editors.

Description of Two new species of Fossil Footmarks, found in Massachusetts and Connecticut, or of the Animals that made them. By E. Hitchcock. In 'American Journal of Science,' vol. iv. new series, p. 46. November, 1847. 12 pages, with 3 woodcuts.

Fossil Footprints—Reclamation. By Dr. J. Deane. In 'American Journal of Science,' vol. iv. new series, p. 448.

Fossil Footprint of a new species of Quadruped. By James Deane, M.D. In 'American Journal of Science,' vol. v. new series, p. 40. May, 1848. 1 page and a sketch.

Fossil Footprints. By Dexter Marsh. In 'American Journal of Science,' vol. vi. new series, p. 272. November, 1848. 3 pages and sketch.

The Fossil Footprints of the United States, and the Animals that made them. By E. Hitchcock. From the Transactions of the American Academy of Arts and Sciences, vol. iii. 128 pages, and 24 quarto plates, describing 52 species. 1849.

Notes on some recent Footprints on Red Mud, in Nova Scotia. Collected by W. B. Webster, of Kentville. By Sir Charles Lyell. In Proceedings of London Geological Society. February 21, 1849.

Illustrations of Fossil Footprints of the Valley of the Connecticut. By James Deane, M.D. In Transactions of American Academy of Arts and Sciences, vol. iv. 16 pages and 9 quarto plates. 1849.

Footprints in the Coal-strata of Pennsylvania. By Sir Charles Lyell. 10 pages and 3 figures. In 'Second Travels in the United States,' vol. ii. p. 228. 1849.

On the Fossil Footmarks of the Red Sandstone of Pottsville. By Isaac Lea. From Transactions of American Philosophical Society, 'American Journal of Science,' vol. xiv. new series, p. 457.

Pennsylvania. By Professor H. D. Rogers. In 'Annual of Scientific Discovery,' 1851, p. 314.

On the Foot-tracks in the Potsdam Sandstone of Lower Canada. By Sir William Logan. In "Report on the Canadian Survey," 1851–2. 'Annual of Scientific Discovery,' 1853, p. 304.

On the Tracks of Gasteropoda, Crustacea, etc., in the Clinton group of New York. By Professor James Hall. In 'Palæontology of New York,' vol. ii. p. 26. 1852. 11 pages, 7 quarto plates.

Remarks on the Fossil Impressions in the Sandstone Rocks of Connecticut River. By Professor John C. Warren, M.D. 1 vol. of 54 pages and 1 plate. 1854.

On the Footprints occurring in the Pottsdam Sandstone of Canada. By W. E. Logan, Esq. In 'Quarterly Journal of Geological Society,' 1852. p. 199.

Description of the Impressions of Footprints of the Prototichnites, from the Pottsdam Sandstone of Canada. By Professor R. Owen, F.R.S. In 'Quarterly Journal of Geological Society,' 1852, p. 214, with 10 plates.

On recent Bird-tracks on the Sand of the Bay of Fundy. By J. L. Hayes. In 'Annual of Scientific Discovery' for 1851, p. 314.

On the Reptilian Footprints in the Carboniferous Rocks of Eastern America; Impressions (chiefly Tracks) on Alluvial Clay in Hadley, Massachusetts. By Charles H. Hitchcock. In 'American Journal of Science,' May, 1855. 5 pages.

Fossil Footmarks on the Red Sandstone of Pottsville, Pennsylvania. By Isaac Lea. 16 pages super-royal folio, with 1 double lithographic plate. 1855.

On a Few Fossil Footprints (*Gigandipus caudatus*). By Edward Hitchcock. In 'American Journal of Science,' new series, vol. xxi. p. 96. 3 pages and a sketch. January, 1856.

On New and Remarkable Gigantic Fossils and Footmarks. By John C. Warren, M.D. Read before the Boston Society of Natural History, January, 1856. In 'Boston Daily Traveller,' January 24th, 1856.

Additional Facts respecting the Tracts of *Otozoum Moodii* on the Liassic Sandstone of the Connecticut Valley. By Edward Hitchcock. In Proceedings of American Scientific Association, 1856, p. 228.

On the Sandstone Fossils of Connecticut River. By James Deane, M.D. 6 quarto pages, with 3 plates. In 'Journal of the Academy of Natural Science,' second series, vol. iii. March, 1856.

Connection of Fossil Footprints with the Theory of Progressive Development. By Professor H. D. Rogers. In 'Annual of Scientific Discovery,' 1856, p. 314.

Fossil Footprints. By Professor J. Wyman. Discovered by Professor H. D. Rogers, in Carboniferous strata, Pennsylvania. In Proceedings of Boston Society of Natural History, vol. v. p. 258. 'American Journal of Science,' vol. xxi. new series, p. 441. May, 1856.

Notice of *Chelichnus Wymanianus*. By Isaac Lea. In 'American Journal of Science,' vol. xxii. new series, p. 123. July, 1856.

Ichnology of New England. A Report on the Sandstone of the Connecticut Valley, especially its Fossil Footmarks, made to the Government of Massachusetts. By Edward Hitchcock. 1 vol. quarto, of 232 pages, with 60 plates, illustrating one hundred and nineteen species of the Connecticut Valley, 1858.

It would interfere with our plan, however, to enter here into details of these footprints, and we shall therefore pass on to the first notice of the actual remains of birds in this formation, reserving hereafter a chapter especially devoted to Ornithictites, and the evidence they afford of the classes of birds or animals that made them. This occurs in Mr. E. Emmons's 'American Geology,' part vi., published at Albany, N. Y., in 1857, where at page 148 is the following description:—

"AVES, or Birds.—*Palæornis Struthionoides*, n. g. (E.). It is a remarkable fact that the remains of birds are so rare in the sandstones and shales in which their footprints are so common. The only fragment of a bone which has been obtained in the country, which could be referred to this class of warm-blooded animals, I procured from the red and variegated sandstones of Anson County, N. C. It is a portion of the sacrum (fig. 114), natural size, and contains six vertebræ anchylosed together. The figure shows the under side, and brings to view their perfect confluence. Upon the sides these bodies are seen projecting laterally from the mass of bone. It is three and one-half inches long, one and six-tenth inches wide, and one and two-tenth inches thick. (See Pl. IV.)

"A microscopic examination of the bone-cells (fig. 115) confirm s the opinion expressed relative to the class of animals to which it belongs. 1, shows the bone-cells of a fish; 2, those of a reptile; and the remaining five the cells of the bone under consideration. The size of this bone proves that it belonged to a large heavy bird. The width of the same bone in the eagle is half an inch. It is more than three times the size of the largest of the kind, but it is not the proper bird with which to compare it, for it is highly probable that it more resembled the *Struthiones*, or ostriches,—birds with thick toes,—than any other living family. Its specific name has an allusion to this resemblance. The footprints of birds are mostly made by those which possessed toes of this description, especially those which are confined to the sandstone of the valley of the Connecticut."

The first notice of bird remains in the Oolite of England was given in the 'Quarterly Journal of the Microscopical Society of London,' 1857, vol. v. p. 63, in an article, illustrated with plates, "On the Existence of BIRDS during the deposition of the STONESFIELD SLATE, proved by a comparison of the MICROSCOPIC STRUCTURE of certain BONES of that Formation with those of RECENT BONES. By the Rev. J. B. P. Dennis, F.G.S., of Bury St. Edmund's."

From extensive observations made upon the bones of birds, Mr. Dennis found that in their microscopic characters, these bones are as distinct from those of mammifers as the latter are from the bones of saurians. "As the lacuna in the saurian bone exceeds that of the mammal in the size of its canaliculi, so does the latter exceed that of the bird; and as they are more numerous and more branched in the bird than in the mammal, so, in like manner, are they more so in mammalian than in saurian bone." "It is in birds," he continues, "that the Haversian tubes attain their most elegant and varied reticulations, not fortuitously, but with design, and that intimately connected with the life and habits of the animal. In fact, each bone is a study in itself, and involves a knowledge of the muscles that move it, as well as of the use it is designed for."

The object of his paper, Mr. Dennis says, "is to prove, from a general exposition of the structure of birds, that they had representatives on this planet when the Stonesfield Slate was still the soft mud of a large estuary;" and for this purpose he enters (for the thorough

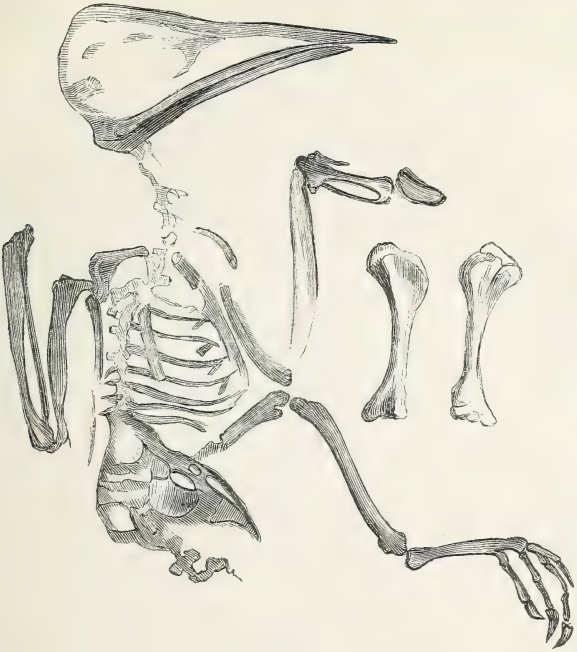

Fig. 1.

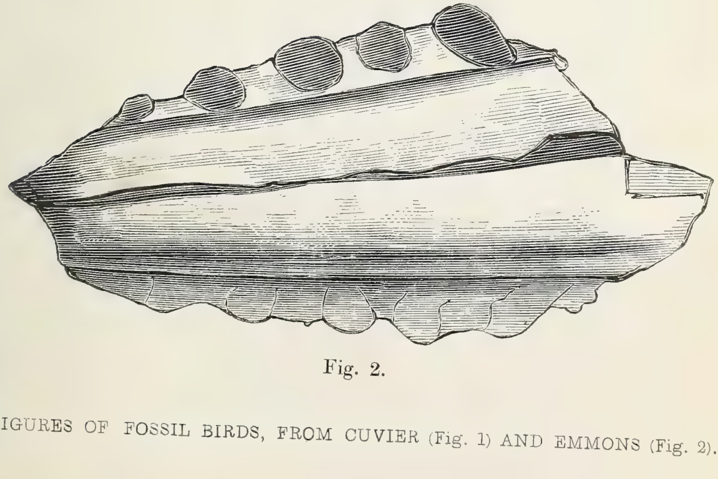

Fig. 2.

FIGURES OF FOSSIL BIRDS, FROM CUVIER (Fig. 1) AND EMMONS (Fig. 2).

elucidation of the question) into the consideration of the structure, not only of birds but of both mammals and reptiles also, the latter, by the Pterodactyles, being intimately connected with the subject.

"Amongst mammifers, the bats alone have the power of maintaining a continued flight, by the rapid vibrations of membranous wings, which are in fact but a modification of the arm and hand, so adapted as to enable them to extend a thin canvas by which their bodies are drawn through the air. To this end the fingers are greatly increased in length as well as the humerus and radius; the scapula also is large, and lengthened in a slanting direction at its lower portion for the better attachment of muscular power; and to afford greater support to the stroke of the wing; the clavicles are curved like the furcula of the bird, and perform the united functions of the furcula and coracoids, preventing the compression of the chest, and keeping the humerus in its place when acted upon by the pectoral muscles. . . . But there is no deviation in this flying mammal from the plan nature has laid down for the construction of mammifers; the bat, because it flies, is not a bird, no more than the bird that swims and cannot fly is a fish. . . . The wing of the bat is in accordance with the same design that framed the hand of man. . . . The bones of bats are excessively strong, hard, and semitransparent. . . . The muscles of the fore arm are extremely insignificant when compared with those of birds; their bones are harder in texture, and only the very large bats possess Haversian tubes, even the largest indigenous to this country are without them;* and the Pteropus, the largest of the family, has only short and straight ones, and these not at all numerous. . . . In fig. 1, pl. vi. are shown the Haversian tubes and lacunæ of the Pteropus or flying fox, as it is popularly called; the Haversian tubes are more like long lacunæ, and are in the humerus straight, unconnected, and not numerous, but the lacunæ are very abundant; these become more fusiform in the phalanges (fig. 2). . . . The canaliculi of the bat are large for mammals. . . . I conceive the reason of the paucity or absence of these tubes (the Haversian) in the bats is to be found in the character of their wings, and the habits of the animal. Bats require light but strong bones, hardly at all flexible, for were they so the great length and slenderness would make the wing so pliable that it would be powerless in resisting the air, and thereby enabling the animal to sustain itself in flight. Lightness is obtained by numerous lacunæ, and numerous and comparatively thick canaliculi, and no more elasticity is imparted to the bone than is sufficient to preserve its structure, and obviate any fracture in flight. In the bird, on the contrary, elastic resistance to muscular pressure is of much importance; and hence appears to have arisen that admirable application and adjustment of the Haversian tubes so conspicuous in the economy of birds. . . . Besides bats there are other mammifers, such as the Galeopithecus, flying Phalangers, etc., which . . . are enabled to perform flights to some extent by the aid of a lateral extension of their skin, which being spread out like a parachute sustains them for some time. . . . In the smaller flying Phalanger the Haversian tubes, especially in the tibia, are large and numerous, the lacunæ are very numerous, and the canaliculi large; every particle of unnecessary weight seems to have been abstracted from their bones, that the light animal may float almost like a feather in the air (fig. 3). . . .

"Amongst recent reptiles, the *Draco volans* is enabled, by an extension of its false ribs, to expand a fan-like membrane, by which it can . . . for a little time sustain itself in the air. . . . The bones of this most interesting reptile are hollow and thin, but strong, without Haversian tubes, and having numerous lacunæ; the canaliculi are fine for a reptile, but partake in other respects of the reptilian characters. . . . The gannet, being peculiarly characterized by the length of its wing-bones, is a very appropriate bird to compare both with the bats and the Pterodactyles; . . . the humerus, radius, and ulna partake of the (microscopic) characters observed in all birds whose wings are long and pointed. In the humerus vertical section (fig. 17) the Haversian tubes do not reticulate, but run nearly parallel, and ultimately converging to a point, from which extends another tube, which converges in a similar manner. . . . In the transverse section the Haversian tubes appear as round dots, the lacunæ as small irregular specks, and the canaliculi beautifully reticulate, etc. . . . Furcula, fig. 18, coracoid, fig. 19, femur, fig. 20; transverse section, fig. 21; tibia, fig. 22, rib, fig. 24; furcula of swift, fig. 6. . . . The structure of the gannet . . . in the principal bones admirably exhibits the beautiful adaptation of the microscopic structure of bone to the movements, habits, and well-being of the creature; and in no bone is that adaptation more closely shown than in the coracoid—the circular reticulations of the Haversian canals in which bone are assuredly designed to enable it to sustain the shock it must receive when the bird impinges on the water. . . .

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* In a footnote Mr. Dennis states that he has "found them in the jaw, a thick stem with a few straight branches between the fangs of the teeth."

"For ordinary purposes, the gelatinous homogeneous bones of fishes seem sufficiently strong for their mode of living, but a much more elaborate structure is requisite in the higher vertebrata. . . . In the *Ichthyosaurus* and *Plesiosaurus*, the canaliculi, though finer than those of some other saurians, are few in number; hence their bones are perfectly distinct from those of mammifers or birds."

Mr. Dennis then passes on to the more direct consideration of the structure of birds' bones:—

"Comparisons," he says, "with the same bones in birds of similar flight and configuration of the wing are highly useful in elucidating this subject. Take, for instance, such birds as the ring-dotterel; turnstone, dunlin, pigmy curlew, little stint, and other birds of that description, whose mode of flight is so similar that . . . the most practised sportsman 'cannot' distinguish one from the other by its flight. If we examine a portion of the ulna taken from the same part of the bone in any one or all of these birds, we shall at once observe a similar and singular correspondence in the disposition of the Haversian tubes. Examine next the ulna of the greensand piper, a bird whose wing is broader . . . and not so pointed, . . . and whose flight is easily recognized from its congeners, . . . and there is 'an entirely different arrangement of the Haversian tubes, which are reticulated in every direction, while in the rest they observe longitudinal directions."

What conclusion can we arrive at, Mr. Dennis asks, but that these tubes are arranged in accordance with the flight of birds? and in confirmation of this view he points out that the starling, raven, jay, etc., in which the secondary quills are well developed, have all fine and numerous reticulated tubes:—

"In the fowl they are very powerful, and the ulna contains numerous and fine tubes; in the owls the same; in the hawks the Haversian tubes are large and much reticulated, and are easily recognized from those of other birds. It seems therefore possible, from the microscopic structure of the bone of a bird, to divine the shape of its wing and the character of its flight, there being a perfect correspondence one with the other, just as a perfect knowledge of the femur will inform us whether a bird could swim, or only ran or walked."

And this, he thinks, may be done even from a fragment of a bone, "after we have acquainted ourselves with the general principles by very numerous and exact observations."

"In the coracoid, for instance, the ordinary disposition of the Haversian tubes would be longitudinal, braced more or less, because that would be the best arrangement to resist the powerful action of the pectoral muscles. . . . The ulna of the razor-bird and guillemot is more reticulated than would primarily be expected in the wing of a bird when the secondary quills are so very weak; but then it must be considered that those birds use their wings much more like fins when under water than as instruments of flight," etc.

Having so far grappled with the general features of the microscopic characters of birds, Mr. Dennis takes up the microscopic structure of Pterodactyles. It must not, however, be forgotten that we are quoting an author who was amongst the first to investigate the subject, and whose painstaking and details are therefore the more worthy of credit to himself, and useful to the student, from their elaborate minuteness.

"The *Pterodactylus longirostris* perhaps affords us the most perfect means of studying the singular proportions of its skeleton. A larger and less perfect, but exceedingly useful one was discovered by Miss Anning, at Lyme Regis, . . . now in the British Museum. Also portions of the jaws of a very large kind have been discovered in our Chalk formation, with other bones, now supposed to have belonged to a similar animal. From these specimens we learn that the animal was a true Saurian, apparently adapted for flight and for arboreal and terrestrial movements, and instead of possessing, like the bat, an extension of all the fingers, it had only one prolonged, the others being used in progression. . . . We may suppose that the Pterodactyle in some degree in the use of its limbs approached the frog; we may also . . . that the muscular development of the fore arm of the Pterodactyle was something between that of the bat, frog, and bird. The presence of quills in the bird has evidently materially affected the muscular development of the fore-arm; as also their being bipeds involved a greater development of the muscles of the leg. . . . In the Pterodactyle the strain upon the bones of the wing would be principally in the long direction, there being no lateral pressure from feathers being attached to the bone. In the bird . . . the Haversian tubes vary according to the shape and uses of the wing, but there is no reason to suppose that such variations would be required in the Pterodactyle. In the Phalangers they extend longitudinally; we may therefore suppose that such was the case in the Pterodactyle. . . .

"Next, with regard to the lacunæ, of what shape would analogy teach us to expect them to be in the Pterodactyle? Surely long pointed ovals; as, indeed, they have been so figured, only the mistake made was in supposing such a shape was peculiarly characteristic of the Pterodactyle, whereas the shape of the lacuna is characteristic of no class or order of vertebrate animals, but is only connected with the requirements of the bones of the animal, and may be long or round in the same animal as occasion requires."

After writing the above remarks, Mr. Dennis received from Mr. Henry Catt a portion of bone from the chalk of Brighton, which exhibited precisely these characters. Writing of it, he says:—

"The Haversian tubes are principally longitudinal; the lacunæ are long, like those on the bill of the pelican,—and, indeed, the Haversian tubes may nearly compare, especially in size. There is, however, a peculiarity I was not prepared for, having observed it in no bird-bones, though I have noticed something like it in the frog. It is the way in which the lacunæ cross.* There appears to be a set running longitudinally, and a set above them running in the opposite direction, which gives a very *marked and peculiar character* to the bone, and makes me think the bone from the Chalk, and which is a hollow bone with very thin walls of a peculiar texture,† is Pterodactyle bone. Another thing confirms me in this view: the canaliculi are not numerous, like those of birds (fig. 7 and 14); if so, this is a further confirmation of those general principles I laid down in a previous paper on the characteristics of bone,—the Pterodactyle, though it could fly like the bird or bat, yet showing its saurian characters, both outwardly and inwardly in its bones."

Mr. Dennis then takes up that topic with which we are now most interested,—a bone from the Stonesfield slate, which he assigns to the class of birds. The fossil bone which Mr. Dennis submitted to examination was selected from several other supposed fossil bones of birds from that stratum, belonging to Mr. Adams, of Buriton, Petersfield. It was selected as one of the greatest interest, from its striking similarity in structure to the humerus of the heron. It belonged, according to Mr. Dennis, to a smaller kind than our common heron, and appears from a drawing which, with some fragments only of the bone, was all that he received, to be the distal end of the humerus of the heron. The bone possesses "quite the texture of bird-bone in its outward appearance, and is decidedly different from that of the Pterodactyle from the Chalk, which looks rather silky, an appearance apparently caused by fine lines on its surface, which the bird-bone is free from. The vertical section of a portion of this bone gives the following characters:—

"Haversian tubes for a bird of moderate thickness; reticulate, but without any precise form or size in the loops, but rather a marked irregularity is shown, some appearing square, others triangular, others oval,—in fact, of all shapes and sizes; sometimes they somewhat interlace; they do not entirely maintain a uniform diameter, the reticulations are inclined to form combinations, which produces a variety in their appearance, sometimes two or three of a similar shape and size uniting. The lacunæ are numerous, small ovals and round, but more pointed ones than round. The canaliculi are fine, much branched, and very numerous."

That this is the bone of a bird, from the evidence adduced, Mr.

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* In a footnote, Mr. Dennis says he has observed something like this crossing in the skulls of some birds and in the bone-plates of the Armadillo.

† Such are the familiar characteristics of the known Pterodactyle bones from the Chalk and Jurassic strata.—Ed. Geol.

Dennis thinks there can be no doubt; and he therefore proceeds to attempt to discover what kind of bird it might have been. "We have no reason," he says, "to suppose it belongs to the Raptores, for it does not exhibit their peculiarities of structure, the Haversian tubes being peculiarly large in the diurnal birds of prey. Neither did it with much probability belong to the Corvidæ, for in them they are finer and more reticulate; still, neither did it belong to the Columbidæ or the gallinaceous family." All the goose, duck, and gull tribes, with the divers, perhaps mergansers or cormorants, may also be excluded, for they are reported, as far as Mr. Dennis has examined them, to have marked distinctions. By this process of separation, Mr. Dennis narrows the field of research, and "leaves us with the cranes, herons, egrets, and bitterns, and birds of that description," to discover a living representative of this ancient bird. He then attempts to show that "our common heron exhibits a very marked agreement in many particulars." "The bones of the heron, like those of other animals, exhibit a varied adaptation of their Haversian tubes, and certainly do not compare with the fossil in some of them,—as the tibia, for instance; but in the humerus there is a very great similarity, more so than in the ulna or radius. The Haversian tubes in the humerus appear to be constructed on the very same plan, so that a description of the one would be a counterpart of the other, only they appear rather larger in the heron. The lacunæ have also the same shapes, with nearly the same admixture of round ones, the heron appearing to have a greater number. The canaliculi also perfectly agree. Supposing the fossil bone to have been a humerus, its correspondence with the humerus of the heron would indicate that its wing was similar in shape, and its mode of flight corresponding." "Should further investigations," Mr. Dennis concludes, "substantiate this surmise, it will be another triumph of the microscope in the field of science." To these remarks Mr. Dennis adds "Addenda," which contain excellent remarks for obtaining examples of, and preparing bone-structure for microscopic examination, that may be read with much benefit by students and others interested in this subject.

Mr. Dennis's paper is accompanied by a plate (Micr. Journ. vol. v. pl. vi.), in which the following figures of microscopical sections are given:—1. Pteropus; humerus. 2. Bat; phalanx. 3. Flying Phalanger; tibia. 4. *Draco volans;* ulna. 5. Red-throated Diver; tibia. 6. Swift; furcula. 7. Mr. Catt's fossil (Pterodactyle). 8. Pelican; bill. 9. Stonesfield fossil, vertical section. 10. Ditto, transverse section. 12. Heron; humerus. 13 *a.* Heron; humerus. *b.* Stonesfield fossil; lacunæ. 14. Mr. Catt's fossil (Pterodactyle); lacunæ. 16. Heron; lacunæ. 17. Gannet; humerus. 18. Ditto; coracoid. 19. Ditto; furcula. 20. Ditto; femur, vertical section. 21. Ditto; femur, transverse section. 22. Ditto; tibia. 23. Ditto; tarsus. 24. Ditto; rib.

Of these, we have reproduced in our Plate V., as essential to the understanding of Mr. Dennis's arguments, fig. 9 to 16, namely the two vertical, and the transverse sections, and the lacunæ of the Stonesfield fossil; with the sections of the heron and Pterodactyle bones for comparison. Of these figures, 13, 14, 15, 16 are magnified 300 diameters; the remainder 75 diameters.

(*To be continued.*)

CORRESPONDENCE.

Human Remains and Flint Hatchets.

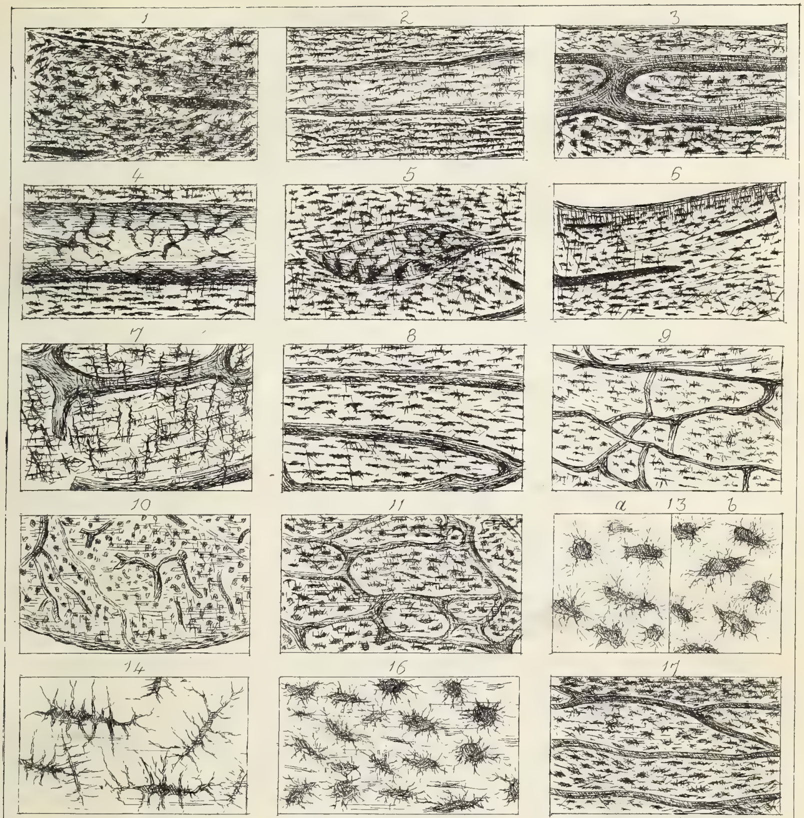
Sir,—Some weeks ago, in passing hurriedly through Normandy, I visited the museum of the ancient town of Bayeux, and was surprised to see in the same glass-case several flint-hatchets, etc., and various human bones. I anxiously made inquiry of the ancient librarian in the room, who, with sparkling eyes, gave ready utterance to his satisfaction at my notice of the contents of the case, and entered fully into a relation of their discovery; of which the following is the substance of a lengthy communication to the editor of 'L'Écho Bayeusain' of the 24th July, 1863, by Éd. Lambert St.-A. Duvant. I am unaware whether this paper is known to the British geologists; if it be not known, perhaps you will publish this communication, and draw attention to this locality; for it appears to me that this discovery, if fully verified, supplies the desideratum alluded to by Sir Charles Lyell in the following passage:—"It is naturally a matter of no small surprise, that after we have collected many hundred flint-implements (including knives, many thousands), not a single human bone has yet been met with in the alluvial sand and gravel in any of the parts of Europe where the tool-bearing drift of the Post-Pliocene period has been investigated in valley deposits." (Lyell, 'Antiquity of Man,' p. 144.)

Augustin Gilbert, a labourer, was occupied in excavating earth for the repair of a road (in the month of March, 1863), near the hamlet of Pont-Roch, on a portion of the territory of "D'Andrieu, called Les Perrelles," close to the banks of the river Seulle; and at the depth of 1 foot 10 inches below the surface, he discovered the remains of a human skeleton, near which was found a deer horn, lying by the upper part of the femur, and higher up, towards the skull, two flint-hatchets close together; a tusk of an old boar, measuring 5¼ inches in circumference, and a portion of a flint knife, of which only 3¼ inches remain of the blade, which is slightly curved at its upper extremity, is still very sharp on both sides; one face is flat, the other has two longitudinal grooves. The flint-hatchets are coated with an opaque substance; they are of different dimensions, quite polished, and worked with remarkable skill; the strongest is 6 inches by a width of 2¾ inches on the cutting edge, diminishing to 1¼ inch at the other end. The smallest, 4¾ inches long, with 1¼ inch on the cutting edge, reducing to ⅝ of an inch at the other end. The knife is of the same class, as regards the working of the material. The human remains are in a good state of preservation; one part of the maxillary bone contained seven perfectly sound teeth. The body was lying with its head towards the rising and the feet to the setting sun.

I am, Sir, yours faithfully,
Patrick Fraser, M.D.

63, Grosvenor Street, Grosvenor Square,
December 12th, 1863.

XII.



MICROSCOPIC SECTIONS OF FOSSIL BONES.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

GEOLOGISTS' ASSOCIATION.—The first meeting of the present session was held, November 3rd, at the rooms of the Medical Society of London, George Street, Hanover Square, whither the Association has removed. A paper was read by Mr. Carter Blake on "Fossil Elephants," which elicited some very interesting remarks from Mr. Charlesworth, Mr. Cresy, and Professor Tennant, the President. Mr. Evans then read a communication on the geology of the railway-works in the vicinity of London, and illustrated his paper by an exceedingly interesting suite of fossils.

MANCHESTER GEOLOGICAL SOCIETY.—The twenty-fifth Annual Meeting was held at the Museum, Peter Street, on the 29th October last. The Report showed the Society in a very prosperous state.

The following gentlemen were elected office-bearers for the ensuing year:—President: Andrew Knowles, Esq. Vice-Presidents: E. W. Binney, F.R.S., F.G.S., Sir Jas. P. Kay-Shuttleworth, Bart., F.G.S., Joseph Dickinson, F.G.S., W. Roby Barr, Esq. Treasurer: Mr. Henry Mere Ormerod. Auditors: R. P. Greg, F.G.S., Mr. James Hertz. Honorary Secretaries: John Atkinson, F.G.S., John Edward Forbes, F.G.S. Honorary Curators: Mr. E. W. Binney, Mr. H. M. Ormerod. Council: Mr. Thomas Ashworth, Mr. John Bradbury, Mr. Joseph Chatwood, Mr. John Cross, Mr. Thomas Farrimond, Mr. Joseph Goodwin, Mr. G. C. Greenwell, Mr. J. J. Horsfall, Mr. Clegg Livesey, Mr. George Peace, Mr. John Taylor, Mr. John Wild.

Representatives of the Society at the Council Meetings of the Natural History Society—Mr. E. W. Binney and Mr. Alderman Harvey.

SOUTH SHIELDS GEOLOGICAL CLUB.—The anniversary meeting was held on the 13th November. In addition to the independent investigations of members of the South Shields Geological Club, the Club have found it exceedingly interesting and instructive to pursue, during fixed winter evenings, a systematic and practical examination of geological phenomena, for which the numerous lithological and fossil specimens in their possession, or procured during various explorations, have supplied ample and admirable materials for comparison and illustration.

The important advantages that have been already derived from the establishment of the Club, have abundantly demonstrated the great value of the application of the co-operative principle, even to the active pursuit of natural science.

The President's Address referred to some points of geological interest connected with the ground traversed during the preceding season, and indicated the special departments that would occupy consideration during the one now approaching.

The coal-fields of Durham and Northumberland are traversed in various directions by Basaltic dykes, which at several points are exposed, and good opportunities afforded for observing them. The most remarkable of these igneous masses in the North of England is the great whin sill, so named, in contradistinction to whin *dyke*, on account of its stratiform character, and general conformability to the stratified beds on which it rests. It is composed chiefly of Greenstone and Basalt, and extends from Brough, in Westmoreland, to within a very few miles of Berwick-upon-Tweed. It is generally of one stratiform mass, but sometimes two, and even three, stratiform beds occur. The course of the whin sill, from the Pennine range, is in a north-easterly direction, and after crossing the North Tyne appears at Bavington, and on the east coast at Dunstanburgh Castle, where it forms a high escarpment facing the sea, and affords the very best opportunity for observing the vertical columnar structure which it here assumes, with the usual lateral jointings. It again appears at Bamburgh Castle and the Farne Islands; at the former, the columnar masses incline to an angle of forty-five degrees, as at Holy Island, where it is again seen, and thence proceeds to the Kyloe hills, six miles northward from Belford.

To account for the introduction of the whin sill into the limestone strata, two theories have been advanced. Mr. Hutton maintained that the Basaltic lava was poured out on the bed of the ocean, at one or more periods, during the deposition of the limestone strata, and thus became interstratified amongst them. Professor Sedgwick, on the other hand, entertains the opinion that the eruptive lava, during a later period, forced its way into the previously deposited rocks, along their surfaces of stratification, and thus elevated the whole mass of superincumbent strata.

Each hypothesis encounters its own peculiar difficulties while endeavouring to account for all the phenomena. From his own observations of the whin sill, which have been confined to its more northern course, the President was led to adopt, in preference, the hypothesis of Hutton. The force required to have horizontally opened and intruded so large a mass of igneous matter into the limestone beds for so many miles would be enormous, and was almost certain to have dislocated and greatly broken the superjacent strata, and to have intruded dykes and veins of Basalt in all directions into the adjacent fissures. Dislocations evidencing great violence in their production, and the intrusion of Basaltic masses, however, are nowhere observable. Of the numerous faults that traverse the northern coal-field, two may be seen in our immediate neighbourhood, namely, the dyke in Tynemouth Cliff, and the ninety-fathom dyke near Cullercoats. The latter is of much geological interest, arising from the vast dislocations and remarkable downthrow of the strata it has effected along its whole uninterrupted course of one hundred and thirty miles. This great fault begins at the northern termination of the Pennine chain, and runs eastward to the sea-coast at Cullercoats, and has caused a relative depression of the limestone strata on the north, estimated at some points at not less than two thousand feet. The depth of the downcast, however, varies much at different places: at Cullercoats it is nearly fifty fathoms. The fault can be best seen and studied at Cullercoats and Whitley, for here it has dislocated not only the coal-measures, but also the Lower Red Sandstone and the magnesian limestone of the Permian series. The beds are invariably depressed on the north side, and dip towards the fault, the plane of the dislocation being about fifty-nine degrees. The surface of the overlying sandstone is marked along the dip of the fault by numerous parallel flutings made by the intruded mass, affording the clearest evidence of the great violence with which the displacement was effected. The course of the dyke from Cullercoats to Gosforth is W.N.W., thence W.S.W. across the Tyne about three miles above Newcastle, and thence W. to Brampton, where it bends in a nearly S.E. by S. direction to Brough; from Brough to Wild Boar Fell nearly S.W., and thence to Graygarth, S.S.W.; from Graygarth to Wharfdale, E.S.E., turning a little more eastward as it approaches the Wharf. The geological age of this great igneous eruption seems pretty accurately indicated. It divides the lower Permian beds at Cullercoats, but does not appear to have dislocated the Triassic Red Sandstones in its western course. It must, therefore, have been intruded either about the time of the deposition of the middle, or of the upper, beds of the magnesian limestone—certainly not later than the deposition of the latter. The course of the Basaltic dyke seen in the cliff at Tynemouth, where it passes into the Permian Lower Red Sandstone, has evidently a westerly direction, but it has not been traced; its relations, therefore, are not precisely known. In mineral character it is a compact labradorite.

Having thus briefly adverted to a few points of geological interest connected with the ground traversed during the last winter evening meetings of the Club, it only remains for me to indicate the departments of geological inquiry to which our attention will be directed during the present season. The coal-measures will receive our first consideration, more especially as they immediately succeed the Devonian system, which has already received some considerable attention. The fauna of the formation, as we shall see, acquires still further development, in harmony with the general law of progression that regulated the introduction of organic existences from the Cambrian epoch, through all the succeeding periods, to the close of the Tertiary, when it culminated in man. It is a curious fact that not a single species of the singular bone-encased fishes of the Old Red Sandstone survived the close of the Devonian period, these fishes not having a single representative in the coal-measures. Seeing the period of transition from the one to the other was apparently quiescent, free from violent or sudden upheavals of the earth's surface, to what causes are we to attribute their extinction? The flora of the Carboniferous system is its distinguishing characteristic, and its exuberant vigour is very remarkable when compared, or rather contrasted, with the paucity and apparent feebleness of the preceding Devonian vegetable forms. The Permian series, another local formation, though not so important, in an industrial point of view, as the Carboniferous, is, nevertheless, one of considerable interest. The attention of the Club will also be directed to this series, the last of the Palæozoic divisions. The formation is so well developed in our immediate neighbourhood, that frequent opportunities will arise for examining together the many excellent sections of the strata it contains.

In conclusion, the President congratulated the members of the Club on the vigour and success that had hitherto characterized their operations, and on their enthusiastic devotion to scientific investigations at once so instructive and entertaining.

COLONIAL GEOLOGY.

GEOLOGICAL NOTES ON THE COUNTRY NEAR MELBOURNE, VICTORIA.

By Thos. Harrison.

Australia offers both advantages and the reverse as a field wherein geology may be studied. Mesozoic strata being absent, or very sparingly developed, the variety of fossils is not extensive; but some of the phenomena observable are by no means devoid of interest.

The very limited portion of the Australian continent which I purpose describing is delineated upon sheet number 1 of the geological map lately issued by Mr. Selwyn,—a reduced sketch-copy of which is enclosed with the present communication (Pl. VI.).

By this map it will be seen that there are at least three classes of strata to be noticed—Silurian, Tertiary, and Volcanic. The site of the Victorian metropolis, together with the suburban townships, comprises the whole of these in various proportions. Melbourne proper, with the exception of its extreme western portion, which is situate on an older volcanic formation, is built almost wholly upon May Hill sandstones and soft laminated shales. The whole of this stratum has evidently been subjected to immense disturbance, it being a matter of no little difficulty to discover a patch many yards in extent within which the beds even approach to a horizontal position. The general inclination of the stratification more often verges on the perpendicular, whilst numerous contortions, folds, and doublings—the upper edges being cut away by denudation, at the same time that the lower are hidden far below the exposed portion—offer an interesting but withal most difficult problem to the geological student.

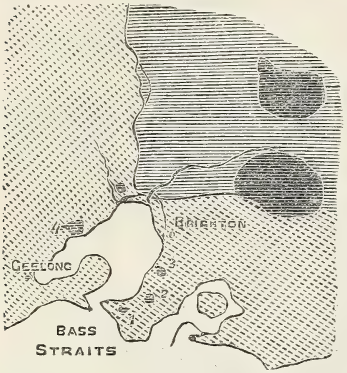


Fig. 1.—The shaded portion is Silurian; the very dark tint, Granite; the dotted, Tertiary, and Tertiary covered by basalt. The references are :—1. Arthur St. 2. Mt. Martha. 3. Mt. Eliza. 4. Yowangs.

Very many of these contortions may perhaps be explained by the supposition of alternate elevations and depressions, but not a few are so intricate as to provoke queries by no means admitting of an easy answer.

In some of the yet unpaved streets of the metropolis, for example, protruding edges of the shales resemble the piles of slates, seen from above, in a stone-mason's yard. Opposite the Supreme Court, several bends in the strata suggest the idea of a loosely-bound book forcibly pressed together from the two ends; the inner and concave side being puckered up, whilst the outer curve is correspondingly stretched and fractured. In a fine section afforded by a cutting in Studley Park, the beds are nearly vertical, leaning towards each other above a pretty clearly developed anticlinal; such anticlinal, however, would seem rather to have been caused by lateral compression than by simply upheaving forces acting from beneath. At Keilor, a township about ten miles on the road to Castlemaine, a natural section displays contortions not unlike the letter S reversed and placed horizontally (part of this curve is shown in the annexed sketch, Pl. II.), traces of the bend being distinctly visible on the opposite sides of the valley,—one of denudation,—at least 200 yards distant. And on removing the surface of Collins Street eight or nine years since, arrangements similar to the ground plan, Fig. 3, presented themselves, none of which seem capable of being accounted for by simple geological forces acting vertically.

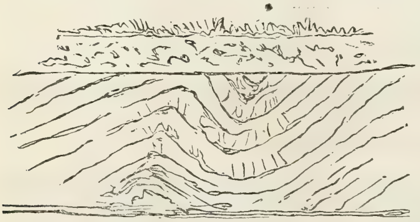
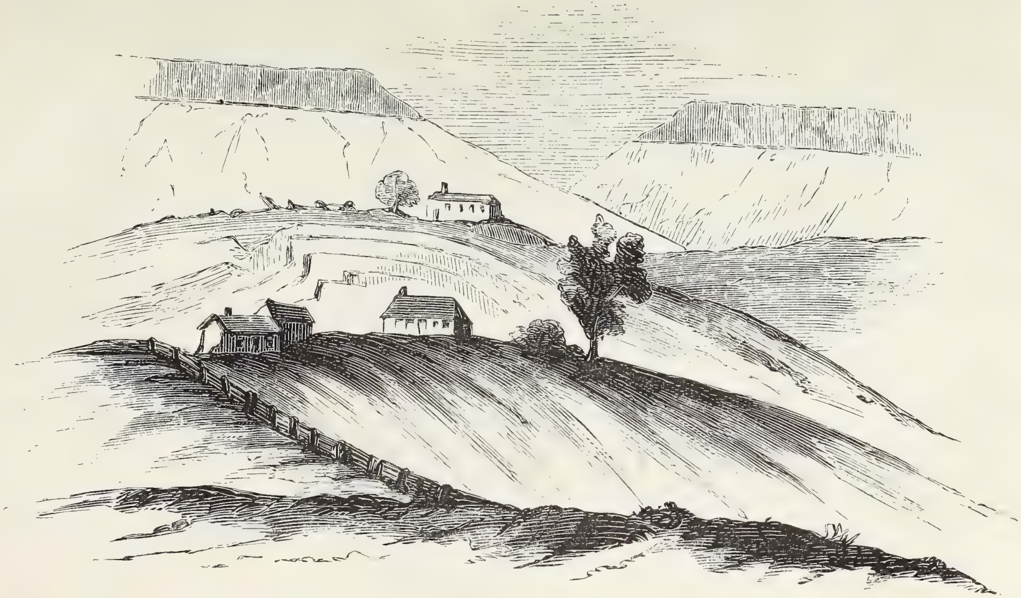


Fig. 2.—Bend in strata at Keilor, opposite side of valley to that represented by Pl. II., and near the spot whence the latter was taken.

A somewhat remarkable feature of the strata referred to, is the frequent protrusion of Elvan dykes. Several of these masses are represented on the map by waving lines. From the condition of the closely adjacent

PLATE II.



BEND IN SILURIAN STRATA, AND HILLS CROWNED WITH BASALT, KEILOR.

S. J. Mackie, del.

[From a Sketch by Mr. Harrison.]

rocks, these dykes would seem to have been thrown up in a heated state They occur in many places, but being generally denuded down to the level of the surrounding rocks, traces of their existence are only discoverable by the accidental labours of the quarryman. The fact that these (the dykes) are of an ancient date is most satisfactorily shown by numerous palæozoic conglomerates being evidently formed from these eroded materials, and from their being seen to penetrate the Lower Silurian rocks, whilst the upper beds of the same formation rest perfectly undisturbed above.

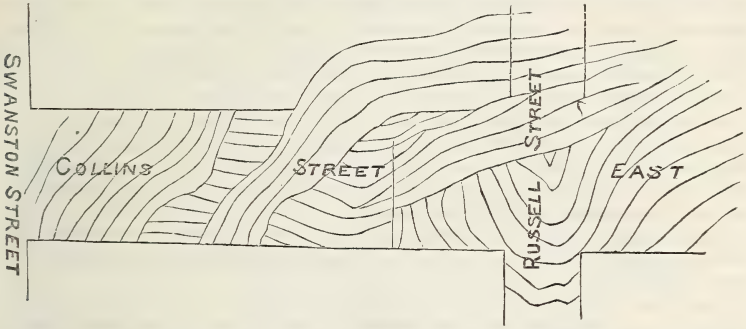


Fig. 3.—View of the strata near the junction of Collins and Russell Streets. I am indebted for the sketch to a paper read by M. Blandowski before the Royal Society of Victoria. The sketch represents the surface as looked down upon from above.

Another feature worthy of notice is found in the quantity of quartz veins with which the Silurian beds are penetrated. The black lines representing these, all having a nearly meridional strike, is quite a feature on maps of the districts wherein they abound. On the diggings, such veins are, as may be supposed, auriferous; but quartz is found in many localities wherein no trace of gold can be discovered. The sandstones of Studley Park, east of Collingwood, are often singularly intersected by this mineral, some of which, even in this locality, would seem to contain specks of the precious metal, since gravel brought from the neighbourhood often displays gold in minute portions. I may mention that the Collingwood Mining Company are sinking a shaft through the "blue stone" (basalt) for the purpose of testing the bottom covered by the detritus of these rocks, and are sanguine of success.

The fossils in the Melbourne Silurian formation are tolerably numerous; but although many of the beds contain a profusion of marine exuvia, literally cemented together, like pebbles in a conglomerate, others are apparently barren of all vestiges of life or its evidences. Such a state of things would seem to tell of periods of repose and subsequent convulsions, long ago, when life became marvellously abundant, followed by others equally extensive, during which every moving thing came to be destroyed, and when only thick beds of sand, fine clay, and dense impalpable mud accumulated in sea-bottoms untenanted by a single organism endowed with life, unenlivened by even a vegetable form.

As avoiding such a theory, I am reminded of an hypothesis put forth by the late Hugh Miller, that in somewhat similar barren rocks alternating with a profusion of organisms, the shells had probably sunk by gravity through the quicksand surrounding them, and that the fossiliferous beds so formed had subsequently been cleared of the remaining sandy particles by the gradual percolation of water through their midst. The particular conglomerates I am describing would, however, appear to present somewhat different conditions, the barren portions being at the bottom and the shelly masses forming the upper stratum,—suggestive, perhaps, that the shells, being light and comparatively large, took a superior position, whilst the more weighty sand was washed or shaken through, on the principle that causes the larger and unbroken biscuits, if I may be allowed the simile, to occupy the upper part of a cask, while the dust and "midshipmen's nuts" just as assuredly seek the bottom.

In consequence of the foldings and contortions to which these Silurian beds have been subjected, as may be supposed, a great variety, both of fossils and lithological characteristics, are crowded into a comparatively small space. Near the Botanical Gardens, situate on the southern banks of the Yarra-yarra, and not far removed from two of the Elvan dykes marked on the map, the strata are composed of soft micaceous sandstone, generally friable, and apparently much broken up and dislocated by past convulsions.

The fossils in this locality are numerous, but small in size; Orthidæ, Leptænæ, with a kind of spiral univalve, probably a Euomphalus, being the prevailing types. Close beside the beds wherein these organisms prevail are others destitute of fossils, but containing nearly spherical bodies of perhaps half an inch in diameter, and generally having a badly defined stem-like projection on one side, the stem being sometimes continued for several inches, until ultimately lost in the surrounding matrix. On being newly fractured, these bodies appear of a fine lake colour, mottled with lighter tints, but fade and become dim after a few days' exposure to light and air. They are not yet named in the University Museum, although some few are therein exhibited. An infiltration of peroxide of iron and manganese may perhaps account for both the colour and the phenomenon; but it is questionable whether these latter substances may not have been attracted by some animal or vegetable remains forming a nucleus, which has since disappeared.

In a quantity of stones recently excavated from a sewer communicating with the Parliament Houses and Treasury—a manor particularly poached over by myself—I have met with Holopellæ (?), Orthidæ (very small), Cuculellæ (the shells still attached to each other, but generally open and filled with the surrounding stone), broken fragments of an Orthoceratite with transverse corrugations, Trilobites, and *Creseis Forbesii.* These latter pteropods, I believe similar to a species now found in the Mediterranean, are especially numerous. The general size is 1½ to 2 inches, although one specimen, unfortunately fractured, must have been nearly 5½ inches in longitudinal dimensions.

The above are nearly always found in the soft sandstones of the locality, whilst the shales of the same place contain large quantities of a species of worm many inches in length, which I do not find depicted in any work on the Silurian deposits in my possession.

At Carlton Butts, about 1½ mile north-east of Melbourne, the fossils, although thinly scattered, are remarkable for being in a remarkably fine state of preservation. Shales and sandstones predominate in this locality also, but are much harder than in the place last described. A peculiarity of the fossils found in this spot is their singularly rich colouring when only recently obtained. On laying open, at a single blow of the hammer, a fine specimen of the tail portion of an Asaphus (?), as it appeared a beautifully sculptured and lake-tinted object on the cream-coloured mass of surrounding stone, I almost thought the fossil some new species of moth or butterfly miraculously imprisoned in a rocky matrix. The colouring is not confined to particular organisms, but is due probably to the same causes as are the colours of the fossils in the Botanical Garden quarries.

Moonee Ponds is, and perhaps will long remain, the most plentifully stocked preserve for the Melbourne collector. The prevailing rocks are shales and sandstones, the latter, in many places, being literally made up of marine exuvia, matted together, organism upon organism, in such a manner as to render the extraction of a perfect fossil a matter of some little difficulty.

The general custom of these beds as depicted on both maps, but more especially that which shows the surrounding country on a smaller scale, present an outline peculiarly suggestive. It will be observed that the borders of the formation are turned principally towards south and westerly points of the compass, the eastern boundary abutting against the granitic and porphyritic masses of the Dandenong ranges. Seen alone, as there represented, the above fact might be deemed hardly worthy of remark; but the bold cliff-like escarpments which form the outline in many places, such escarpments having almost invariably a south or westerly aspect, suggests the cause, and tells of strong currents, oceanic action, and a steep and rocky shore exposed to the full fury of an extensive and stormy waste of water. Near Melbourne, in Studley Park, overlooking the flats of Richmond and Collingwood, the feature alluded to is strikingly apparent. Standing on the lower ground, the resemblance to a precipitous coast is especially manifest; whilst gazing from the summit, one is almost inclined to fancy the many undulations of the ground below are the arrested billows of some ancient sea. At times, as a thick fog covers the plain beneath, and when the higher portions of city and suburb just peep out of the mist-like islets, the old and fancied state of things seems realized; whilst from the Tertiary beds below and their wide extension, almost universal in a south-westernly direction, save in the case of a few granitic masses, Mount Eliza, Mount Martha, Arthur's Seat, and the Yowangs, the student well knows that the time could not be geologically far distant when the waves, breaking near the spot whereon he stands, came rolling in from an expanse of ocean uninterrupted by land, rock, or island, nearer than the Falklands or the Horn.

Tertiary deposits are developed to a great extent over the whole of Australia, and are well represented in the Melbourne district; more so, in fact, than appears upon the map, since they both overlie and underlie the basaltic lavas, and besides cover with a thin capping in many places the upturned edges of the elder Silurian strata.

A tolerably good view of the Upper Tertiary beds can be obtained by following the line of the Melbourne and Brighton railway, along which, after the first few miles, where Basalt and outlying patches of Silurian rocks are traversed, some thick beds of the newer Pliocene are exposed. In a cutting near Chapel Street station, three or four miles south-west of Melbourne, a junction of the older with the newer rocks discloses a somewhat instructive section. The Silurian beds had there formed an abrupt coast-line, or at least an uneven and rocky bottom, and upon them rests in unconformable stratification the Tertiary sediment above,—forming a number of thin beds, gradually growing less and less curved, until attaining 3 or 4 feet in thickness, when all traces of the uneven bottom is lost by the succeeding deposits being thrown down in nearly level lines.

From this point on the line the same Tertiary beds are exposed in each succeeding cutting as far as Brighton, a suburban watering-place eight miles from the metropolis, on the shores of Port Phillip Bay. On the beach near Brighton, small outcrops of Lower and ferruginous Pliocene beds first present themselves, and, pursuing the line of coast, these are found gradually increasing in thickness until a cliff is exposed some 50 to 80 feet high, formed of the first-mentioned beds above, and the latter lying in conformable stratification at the base.

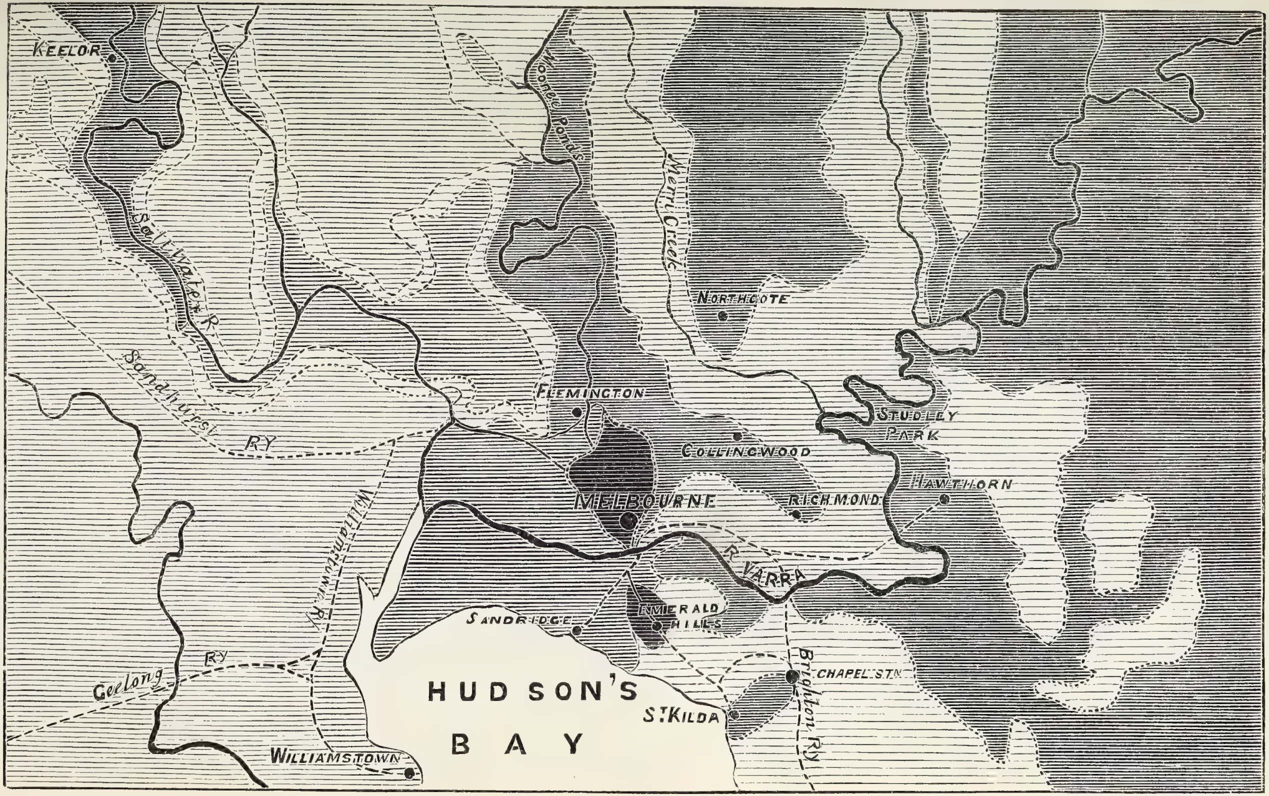
These latter beds are somewhat remarkable near this place (Pic-nic Point) for being filled with a vast number of tubular-shaped bodies, covered on the outside with warty excrescences. These tubes vary in size from the thickness of a straw to that of a man's wrist. Within them there is generally found a core, easily removable by a little gentle pressure. The outside of the tubes in question being harder than the other portions of the strata, they, of course, resist the action of the waves more successfully, and stand out from the containing matrix in singularly bold relief; often, when half imbedded, reminding one of some huge chiton clinging, for bare life, to his stony habitat, upon which he has been left high and dry by the receding tide. Although bearing a very strong resemblance to fossils, the appearances witnessed are generally regarded by local geologists as due to the decomposition of hematite, with which the same kind of rock is known to abound.

The upper beds in this particular spot, represented by a soft arenaceous stone, do not appear to be fossiliferous, but also contain certain tubular bodies —very different, however, from those last mentioned—generally traceable for many inches at a time, and of a chalky appearance, Having forwarded a small hand-specimen to the Rev. J. E. Woods, of Penola, that gentleman suggested they might be a species of fulgurite due to the action of lightning,—a theory which seemed to be especially favoured by the tubes being invariably found in the higher portions of the strata, and nowhere traceable at a few feet from the surface. Subsequent observation has, however, would seem to show that these appearances must be referred to a far less romantic origin than "the fire of Jove;" in fact, on examining them more closely, many appeared to be filled with a black and crumbling substance resembling decayed vegetable matter, and on searching still further, I discovered one in which a piece of wood, evidently the root of a shrub or tree, was still contained. Since then I have met with similar specimens in Melbourne among some Tertiary rocks near the gaol, and also at Northcote, where a thin capping of newer Pliocene deposits rests on the Silurian strata. In this latter instance I observed many recent roots, running downward into the loose rock almost perpendicularly, around which the sand and fine gravel appeared to be invariably hardened into a cemented pipe-like mass. Having tested these tubes with muriatic acid, I should not expect them to contain lime, as I once supposed. More probably, the potash in the wood combining with the surrounding quartzose sand, has given rise—first to a solution, and afterwards to a deposition of siliceous particles.

Much of this district, near Brighton, is covered on the surface by deposits of shells several inches in thickness, wherein Cardium, Turbo, Trochus, Haliotis, and other species having representatives in the adjacent sea, are found in great abundance. In some places, these shelly deposits, being mixed up with arenaceous matter and small pebbles, by afterwards partially decomposing form a soft, easily broken, shelly gravel or conglomerate, interesting to the young geologist, since he can thus readily trace every step of the process which changes the loose sand, unconsolidated pebbles, and aggregated shells, into a tolerably firm and stony rock of highly fossiliferous character.

The evidence of these shell-beds goes far to show the very recent upheaval of the surrounding district. A little observation will, however, reveal traces of more than one phenomenon of this description, together

PLATE IX.



MAP OF MELBOURNE DISTRICT, VICTORIA.

[The area included is about 200 square miles.]

with a corresponding submersion. At the immediate junction of the lately-described Upper and Lower Tertiary beds, for example, not only is the upper surface of the latter waterworn, but the rock itself, for many feet in depth, is fretted into numerous fissures, subsequently filled up with material exactly corresponding with that comprising the rock above; thus a distinct proof is afforded of the underlying rock having formed an old coast-line, or at least a rocky eminence nearly awash with the waves, from which position the whole afterwards sank sufficiently deep below the water to allow of nearly 20 feet of newer strata being deposited at a later period.

Still further proof of these changes of level is afforded by certain formations around Geelong, at which place thick beds of limestone, containing Planorbis, Lymnea, Paludina, and other limestone and fluviatile shells, appear above Miocene and beneath nearly 20 feet of Marine Pliocene deposits; thus necessitating an upheaval over a portion of the country large enough to allow of freshwater lakes being formed, and a subsequent submersion of the whole district, in order that the marine strata might be thrown down.

These continued elevations and depressions of surface are not a little puzzling to the tyro scarce willing to admit the possibility of any such phenomenon in a single instance. The district, however evidently volcanic, would appear to have been especially subject to the changes spoken of,—a rise generally preceding, and a submersion succeeding, each outburst of lava. Nor is it at all improbable, from recent observations, but that the land over the whole of Port Phillip Bay is still rising,* whether to be followed by a renewed outpouring of igneous rocks and a fresh submersion is beyond the power of science to foretell.

No account of the Melbourne district would be complete without some mention of the Basalt—the *bête noire* of the miner, the material of half our public buildings, the substratum of so many Australian plains, the core of so many of our hills, and the allowed source of the colony's fertility. This particular rock is of various ages; no less than three different intrusions or outflows are traceable on the map annexed. The newer or Basalt proper about Victoria, in vast irregularly-shaped patches. On careful exploration, these generally show traces of having been ejected in some higher portion of the land, filling up the adjacent valleys with a once molten but now solidified mass. At first view, few mineral substances would seem less capable of being acted upon by the elements. Yet the fertile soil, composed wholly of basaltic clay and sand, together with huge boulders, masses left by the decomposition of the rock around them, show that so indurate a material is by no means proof against such comparatively weak forces as atmospheric actions. The denuding power of water is also strikingly shown where the Merri Creek has cut its way in a channel, 60 feet deep, through basaltic beds for many miles. Still more remarkable is the denudation of the Keilor Valley. At this place, not only has the Basalt been removed, but 20 feet of Tertiary, and from 30 to 40 feet of Silurian rocks have been cut through also; thus leaving a number of semi-detached hills, each having a base composed of shales and Palæozoic sandstones, strangely distorted by ancient convulsive movements; a middle portion, formed of Tertiary deposits, lyingun conformably upon the older rocks below, and on their summits a thick capping of spheroidal, and in some places columnar Basalt,—a study to the Victorian geologist, little, if any, less instructive than the trap-surmounted hills of Ardèche or the volcanic district of Auvergne.

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* The 'Lightning,' Black Ball liner, lately struck upon a rock near the Heads, which had never been laid down in any chart, probably because the depth at which it lay had decreased since making the first survey of the channel.

Melbourne, September 9, 1863.

NOTES AND QUERIES.

The Graham Shoal.—Several notices have lately appeared in the 'Times' upon the re-discovery of Graham Shoal, off the coast of Sicily, and lying nearly in the track of the mail-steamers running between Marseilles, Malta, and Alexandria. There had been for several years rumours that the shoal had sunk to such a degree as to be no longer dangerous to shipping. To verify this, her Majesty's ship Argus, Captain Ingram, was sent in October, 1861, and employed for several days in searching for the shoal, without success; and from the report of her survey, supported by the opinions of the fishermen of Sciacca and Girgenti, it appeared that the accumulation of cinders and scoriæ that had been heaped up by an eruption of a submarine volcano, and formed the shoal, had gradually dispersed.

When Etna was reported last summer to be in a state of eruption, Mr. Almona, of the Peninsular and Oriental steamship Valetta, mentally connected the fact with Graham's Shoal, considering the same causes that were influencing the larger mountain might also affect the hidden crater, and he determined to give the old spot of the shoal a wider berth in passing. The late survey of the 'Growler' has found the bank again; and whether the 'Argus's' search was in fault, or that it has newly again come to the surface, must be a matter of surmise.

Cretaceous Terebratulæ.—One of the species described by Mr. Lankester in your November number (*T. Moutoniana*, D'Orb.) is a common shell in the Lower Greensand of Godalming. Of the other (*T. depressa*, Lam.), I found a fine specimen at Shanklin, in 1861. The specimen figured on Pl. XXI. Fig. 5, scarcely, however, represents *T. depressa*, as in that species the deltidium is *in one piece*.—C. J. A. Meyer.

Wasium has been described by M. Bahr as existing in Norwegian orthite, in that of the island of Ræsnholm, as well as in the orthite of Ytterby. He finds it in the state of oxide associated with silica, alumina, iron, yttria, ceria, didymia, lime, manganese, etc., but these minerals hardly ever contain more than one per cent. of wasa, or the oxide of Wasium. A paper by M. Nickles is recorded in the Comptes Rendus of the French Academy, in which the existence of Wasium, as a simple body, is disputed, and reasons assigned for believing Wasium to be only a complex oxide, or yttria coloured with a little oxide of didymium or terbium.

Sections on the Lewisham and Tunbridge Railway.—Dear Sir,—In the course of last summer a tunnel was commenced on the new line of railway from Lewisham to Tunbridge, in the neighbourhood of Elmsted Lane, Bromley, where a very interesting and highly fossiliferous deposit has been brought to light.

A considerable tract of country around Bromley is occupied by a thick deposit of rounded flint pebbles in sand, concreted portions of which have long been known as the "Bromley Oyster Conglomerate."

These pebble-beds are exposed in the open cutting at the south end of the new railway tunnel, but no fossils are seen in this section. In the interior of the tunnel, however, the lower portion of the deposit consists of a fine light-coloured pebbly sand and a band of hard conglomerate, both of which abound with a very fine species of Pectunculus (*P. brevirostris*), well preserved. Together with this shell are others, some of which belong to London Clay species, others are those of the Woolwich and Thanet sands series, and several are, I am inclined to believe, undescribed.

The following are those which I have been able to name with tolerable certainty:—*Ostrea Bellovacina, O. tenera, Cardium Plumsteadiense, C. Laytoni, Corbula Regulbensis, C. Arnouldii, Cyrena cuneiformis, C. cordata, C. intermedia, Cytherea, Modiola Mitchellii, Pectunculus brevirostris* (very abundant), *Arca, Avicula, Nucula* (new species), *Cerithium funatum, C. Bowerbankii, C. Lunnii, Calyptræa trochiformis, Auricula pygmæa, Fusus latus, F. gradatus, Melania inquinata, Murex, Melanopsis buccinoides, Natica glaucinoides, N. subdepressa, Neritina globula, Odostomia, Pseudoliva semicostata, Pitharella Rickmanii, Ringicula turgida, Tornatella, Trophon subnodosum, Valvata, Serpula, Lamna.* To these I add, with some doubt, *Sanguinolaria Edwardsii, Anomia, Fusus tuberosus, Scalaria Bowerbankii, Neritina concava, Eulima* or *Rissoa.* I also add, on the authority of my friend Mr. C. J. A. Meyer, *Lucina, Tellina, Teredo, Melania* (? new species), *Melanopsis ancillaroides, Scalaria* (? new species), *Fusus* (? new species), *Turritella, Otodus.*

My friend Mr. Bott possesses a fine specimen of *Pholas* from this spot.

A few weeks since I directed the attention of Mr. Edwards to this locality, and as that gentleman appears to be much interested in these fossils, proper notice will doubtless be taken of any new species.

A deposit of pebbly sand is evidently the production of water having considerable transporting power. It is therefore not surprising to find, that since the most abundant fossils are of marine species, those of a fresh-water or estuarine character, such as *Cyrena, Melania, Pitharella,* etc., are much waterworn. The relative position of this bed is not shown in the sections now exposed, as the pebble-beds extend to the top of the hill. It is, I believe, about 60 feet above the Chalk, from which fact, and also from the general character of the beds, I feel inclined to place it at or near the top of the Woolwich series of beds, and not far below the London Clay. This is the position assigned by Mr. Prestwich to the conglomerate bed in Sundridge Park.

It will also be interesting to state that the long tunnel at Sevenoaks, on the same line of railway, cuts through the Neocomian or junction beds between the Weald Clay and the Kentish Rag. At the south end of the tunnel clay and stone, with *Cyrena, Paludina,* etc., are seen in the spoil-heaps around the shafts. Following the tunnel to the north (the line of the dip of the beds), clays with *Cerithium* appear, which are succeeded by more sandy beds abounding in marine fossils, *Arca Raulinii, Perna Mulletii, Corbula elegans,* etc.

Above this bed is a thick deposit of Kentish Rag and Hassock. I hope on a future occasion to be able to furnish you with a list of the fossils from this bed.—Yours truly, CALEB EVANS.

3, *Devonshire Hill, Hampstead,* 10*th December,* 1863.

MISCELLANEOUS NOTICES.

The following geological and archæological articles appeared in the 'Dublin Quarterly Journal' for May last year:—"On the Flint Implements found in the Gravel of St. Acheul, and their mode of Occurrence," by J. Beete Jukes, F.R.S.; "Report of Council of Dublin Geological Society for 1862–3;" "On the Chemical and Mineralogical Relations of Metamorphic Rocks," by T. Sterry-Hunt, F.R.S., of the Canadian Survey; "Description of an Oak Pile found in the Lake of Geneva," by Mr. Starkey.

The 'Annales de Chimie et de Physique' for August last, contains a note by M. Regnault "On an Apparatus for the Fractional Distillation for estimating the Venale Value of the Essential Oils which are produced by the Calcination of Coals and Schists."

The 'American Journal of Science' for November, 1863, contains the following articles:—"On certain Parallel Relations between the classes of Vertebrates, and the bearings of these Relations on the question of the Distinctive Features of the Reptilian Birds," and "On the Classification of Animals based on the Principle of Cephalization," by Professor J. D. Dana; "On the Rocks of the Quebec Group at Point Lévis," by Sir William E. Logan; "Remarks on the Causes producing the Different Characters of Vegetation known as Prairies, Flats, and Barrens in Southern Illinois, with special reference to Observations made in Perry and Jackson Counties," by Herr Engelmann, of the State Geological Survey; "On the Earth's Climate in Palæozoic Times," by T. Sterry-Hunt, F.R.S., Chemist to the Canadian Survey. Amongst the notices are:—"On the Phosphatic or Guano Rock of the Island of Sombrero," recently described as a new species of mineral by Dr. Phipson, under the name of Sombrerite. This notice is by M. Julien, a resident chemist at Sombrero, who gives a great deal of information about its extent and physical characters, disputes the accuracy of Dr. Phipson's statements, and asserts that the Sombrero guano is as variable in its composition as any other phosphatic guano, and as little entitled to rank as a new species. "Dr. Phipson," he adds, "cannot possibly have examined with any care a single cargo, I venture to say not even a single ton; for there is no natural standard by which a representative specimen could be 'well chosen' or chosen at all." "On the Nature of Jade, and on a new Mineral Species described by M. Damour," by Mr. T. Sterry-Hunt. Geological Survey of Canada: Report for 1863.

The following books and papers have been recently published:—'List of the Echinoderms sent to different Institutions in exchange for other Specimens, with Annotations on the Characteristics of the Species, Localities, Authorities, etc.' By A. Agassiz. 'Beiträge zur Kenntniss der fossilen Pferde und zu einer vergleichenden Odontographie der Hufthiere im Allgemeinen.' By Prof. L. Rütimeyer. Basel, 1863. This work, devoted to the fossil horses and related Ungulates, is illustrated with four plates containing numerous figures. 'Methods of Study in Natural History.' By L. Agassiz. Boston, 1863. Originally delivered as oral lectures, and reported in the 'Atlantic Monthly.' In the Proceedings of the American Academy of Arts and Sciences, vol. v., 1860–1862,—"Atomic Weight of Antimony." In the Proceedings of Academy of Natural Sciences of Philadelphia,' January to July, 1863,—"Descriptions of Fossils from the Yellow Sandstone lying beneath the 'Burlington Limestone' at Burlington, Iowa." In the Proceedings of Boston Society of Natural History,—"Map of North America, illustrative of the Distribution of Land-Shells." By Mr. W. G. Binney. "On the Fossil Crab of Gay Head." By Mr. W. Stimpson. "On the Reptile Bird of Solenhofen." By L. Agassiz. "On the Geographical Distribution of the Sea-Urchin of Massachusetts Bay" (*Echinus granularis*). By A. Agassiz. "Cast of Megatherium set up at the Museum of Comparative Zoology, Cambridge, U.S." By L. Agassiz. "Zircon, Corundum, and other Minerals from Greenwood, Me." By A. E. Verrill. "Copper-bearing Belt of Canada East;" and "On the Magnesian Limestone of the Lower Silurian series of Prairie du Chien containing Crinoids and Fossil Shells." By C. T. Jackson.

REVIEWS.

The School Manual of Geology.

By J. Beete Jukes, M.A., F.R.S., Local Director of the Geological Survey of Ireland. Edinburgh: A. and C. Black. 1863.

If we think it beneath the dignity of Mr. Jukes's position to write school manuals, and regret the time spent on such trivial labours by a man so capable of better work, it is because, having attained to his present rank, and to the command of such powerful resources as fall within the grasp of a director of an extensive portion of the British Islands, we had hoped to see his whole time occupied in working out the material at his command, in a manner alike redounding to his own fame and to the advance of science. We have made the like comments on the popular books of other eminent Government servants, and therefore these are not meant as personally unkind towards Mr. Jukes; indeed, we are quite willing to admit that the book before us is a very nice one, and far more sensible than we anticipated from the title or from the preface when we read in it that "this little book is intended for the use of young persons of fourteen or fifteen years of age." The preface, however, further informs that "it is also offered to grown-up persons who have no time for a more extended study of the science, with the hope that they may gain from it a fair general notion of the scope and nature of that science." The chief difficulty, Mr. Jukes fancies, "the learner meets with in the study of geology, is the want of elementary knowledge of the collateral sciences of physics, chemistry, mineralogy, zoology, and botany," and he thinks, if these sciences were made part of our ordinary education, as they ought to be, it would be easy to teach their application to geology. We do not agree with him. The first great impediment to the propagation of geology is the want of logic and want of certainty of many of its principles; it has not the same certainty of conclusion as mathematics, it has not the self-evidence of experiments in chemistry, it possesses neither analysis nor synthesis, and it wants the efforts of our best men to give its tottering framework solidity. The older workers have thrown in such a lot of rubble, and although geologists have laboured much, it has been isolatedly and independently, every man casting his stone on the rising walls as a passer-by would on a Scotch cairn, until the edifice has risen to lofty height, but without sufficient adhesion. There is material enough for the rough work of the cyclopean building, but it is as rude as the unhewn-stone forts of ancient Northumberland, and the cement and the facing-stones are wanted to complete its strength and the fineness of its finish. There are other difficulties barring the general study of geology, time and money,—time to examine over extensive territories, money to defray the expenses of travel and of collecting. Local geologists working out special areas and subjects may be numerous; experienced geologists ever must be few. No men possess greater advantages for obtaining and elaborating some at least of the required facing-stones of the huge superstructure of geology than the Directors of National Surveys, no other men have the means at their disposal in time, money, or assistance, still less of obtaining the intercommunication with foreign surveys; but instead of grand works such as Agassiz' 'Fossil Fishes,' Hutton's 'Coal Plants,' Owen's 'Odontography,' D'Orbigny's 'Palæontology of France,' Mallet's 'Earthquake Phenomena,' and the publications of the Palæontographical Society, we must be content to buy for our children the "little books" which those great men we wish to look up to, write for our publishers. Luckily, we have no reason to dread a Murchison penning a geological primer for infant schools.

But to take the book as it is, and to view it as one for those who have not time for much study, it is better calculated to give the best running notion of geology with the least amount of trouble of any book we know. The popular doctrines of geology are fairly and moderately put, and although adhering to many of the views which we ourselves have shown a strong antagonism to in the pages of this journal, Mr. Jukes puts them fairly, and, for a school treatise, properly. Such a work is not an arena for controversy, nor would it be fitting in it to go too strongly against the stream of general belief, and it is therefore better and wiser to teach what is generally accepted, and when to that which is not certain the author adds a statement to that effect, he has done all that is required of him. This Mr. Jukes does most fairly, according to his conscience. Take the account of the igneous rocks as an example, on which, after stating the grounds which geologists urge for a molten state of the interior of the globe, and showing that if the temperature increased regularly with depth, as it is supposed to do, say 1° F. for every 100 feet, or 52° F. for every mile, that at four miles deep water would be at boiling-point, at fifty miles the heat would be sufficient to melt steel, and that at a hundred miles the temperature would be 5000° F., which, Mr. Jukes says, is "greater than any that we know at the surface."

> "It is not by any means necessary, however, to suppose that the temperature does increase indefinitely into the interior, or that the rate which regulates its increase near the surface continues to be the same for such depths as those mentioned above. Neither does it follow that the materials, whatever they may be, which exist at great depths, would be melted by the same amount of heat that would fuse them at the surface, since the enormous amount of pressure which they must experience, may keep them solid in spite of the heat."

After this usual supposititious evasion of the discussion of the great difficulties attending the "molten interior" doctrine, Mr. Jukes praiseworthily adds a concluding sentence to his chapter:—

> "Little or nothing," he says, "is known about the constitution or condition of the interior, nor have we any grounds even for speculation, further than those which have been previously mentioned."

The same moderate expression of views of which we have given an example from the first pages, continues throughout to the end, and from the last page we take another similar extract:—

> "The term 'transition' was at one time used to designate an imaginary period between that of the formation of the so-called crystalline rocks and the others. Part of the same prejudice still lingers amongst geologists, and induces them to regard the present time as distinct from the Tertiary epoch, and to introduce such terms as Post-Tertiary or Quaternary."

For those who want to get a fair running knowledge of geology with the least amount of trouble, Mr. Jukes's book will be just the thing. We think highly of Mr. Jukes's ability, and we wish it had been a great work, or a small work on some special topic,—something, in short, beyond an elementary treatise going all over the old ground,—that we might have spoken as much kind praise as we have every pre-existing desire to give to any meritorious labours that emanate from any of the Survey men.

The Flora of Marlborough. By T. H. Preston.

With Mr. Preston's *brochure* as a Flora we may have, seemingly, little to do, but there is an important connection between the plants of a district and the soil on which they grow. This soil may not be necessarily the débris or the resultant of the weathering and atmospheric degradation of the true geological strata of the district, and indeed it may be, as it very often is, formed from a superficial covering of the drifted and over-covering materials of a later and long subsequent age to that of the underlying rocks to which the main outlines of the physical geography are due. Botanists have perceived this relationship, and although they must necessarily regard it in a different light, we find that in local, and even in general Floras, considerable attention is now paid to the geological features of the district or country under botanical description. In this manner the geology of Marlborough is set before us in the little volume we are reviewing, before even the flowers of the region are recorded. This survey of the botanist is especially useful in its way to the practical geologist, because it investigates the superficial covering of the earth in a manner in which he would be little likely to do, and yet not the less important, as by it we obtain a knowledge of the workings of external agencies upon the ground that produces vegetation. In the neighbourhood of Marlborough, we are told that the surface for miles round, and to a great depth, has been entirely formed by these external agencies; the Kennet, as an example, we are told, has at Lockeridge, only four miles from its source, filled up one of its former courses, and made a new track for itself through the marshy ground. On the northern side of the Kennet, the country consists almost entirely of Upper Chalk, with a few outlying patches of red clay on the tops of the hills. In a wood to the north of Mildenhall, there occurs a red stratified clay, more than twelve feet in thickness. About four miles east of Marlborough, on the ridge by the Kennet, there is a vertical fault running nearly north and south; the western side being occupied by horizontal layers of Upper Chalk with flints, and the eastern by a reddish-brown sand, containing flint pebbles up to a pound in weight. Between Graham Hill and Martinsell the chalk is stated to be covered by boulder-clay, which is said also to extend westward as far as Clatford Bottom, and probably to form the subsoil of the greater part of the west woods, and on the eastward runs into Savernake Forest. In the valley to the south of Granham Hill there is a strip of light-coloured sandy clay overlying the chalk, and to the south of this what is called "a mottled red boulder-clay," containing large masses of flint-nodules and sandstone boulders. Near the top of the chalk slope at the north-west corner of the forest there is a trough-like hollow in the chalk, five-and-twenty feet wide and eight feet deep, fitted up with layers of red clay with large broken flints and chalk rubble, and thickly studded with "two kinds of fossil shells of the genus *Helix*, which very much resemble *H. occlusa*, and a smaller species, *H. d' Urbani*, some of which are beautifully marked. This hollow may have been the course of a river during the time of deposition of some of the later Tertiary beds; and a flood probably swept into the layers of broken fragments of chalk and clay, together with the numerous land-shells with which they are studded." About 300 or 400 yards from the spot is a light buff-coloured sand, and on the south side of the pit are hardened blocks of sandstone. The writer thinks this sand was once a part of the Plastic Clay series, at one time covering the district, and of which there are said to be still some remains in the south-east part of the forest. This appears to be, according to the subsequent description, a section showing the "grey weathers" *in situ.* These "boulders" are stated to occur in great numbers in the valleys, especially at Lockeridge and Clatford Bottom, "where they are heaped upon one another in the most promiscuous manner, as if they had been dropped by icebergs." Many are of large size, 90 to 100 tons. An outline of the Bagshot sands and clays also occurs in the Savernake Forest. Of the flora we can only say that it is conspicuously and concisely recorded in separate paragraphs, with bold headings, and is substantially upon the plan adopted by Professor Babington for his 'Flora of Cambridge.' The book is illustrated with a small photographed map of the district, reduced from the ordinary 1-inch survey to within the space of a double page. It wants a scale to indicate distances, and this might be usefully added.

Philosophical Transactions of the Royal Society. Part I. Vol. CLIII. 1863.

This part is a highly important one, containing papers "On the Relation of Radiant Heat to Vapour," by Professor Tyndall; "On the Strains of the Interior of Beams," by the Astronomer Royal, Mr. Airy; "On the Reflection of Polarized Light from Polished Surfaces, Transparent and Metallic," by the Rev. Professor Haughton; "On the Exact Forms of Waves near the Surface of Deep Water," by Dr. Rankine; "The Photo-Chemical Researches of Professors Bunsen and Roscoe;" "On the Immunity of the Stomach from Injury from its own Secretions," by Dr. Pavy; "On Thallium," by Mr. Crookes; and other very valuable papers; but the chief interest to our readers will be the appearance in it, in full, of Professor Owen's memorable paper, read in November, 1862, and briefly reported in our columns. The present memoir is perhaps the most complete that ever was given at first hand of any specimen approaching in novelty and singularity to the present Solenhofen fossil, a drawing of which is given of natural size, executed with great care and skill by Mr. Dinkel. Other illustrative plates accompany the paper, which must be read by those who are interested in the subject, as no abstract would convey more information than the notices and articles we have already printed; and the greatest value of Professor Owen's description lies in the minuteness and details of the numerous comparisons he has made with the bones of recent birds and fossils, Pterodactyles, and the logical conclusions he has deduced from them. The Professor admits the cast of the brain, to which we drew attention in our opening number of last year; but he assigns to a fish a portion of organic substance in the slab upon which Mr. Mackie has made some comments in the 'Popular Science Review,' for the purpose of showing that it is as like a bird's beak with teeth as a fish's jaw. The portion is, however, too obscure for any positive determination, and it will be better not to believe it either a fish's jaw or the Archæopteryx beak at present, but to continue to search diligently for further specimens.

THE GEOLOGIST.

FEBRUARY 1864.

WORK FOR THE FIELD-CLUBS.

BY THE EDITOR.

WITHOUT the slightest wish to interfere with the management, or any desire to criticize the past doings of Natural History Societies and Field-Clubs, we may be permitted, without any imputation of meddling, to suggest how much good work the forthcoming year may produce, through a little forethought and pre-arrangement. Springtime will now soon be upon us, and the time for field-excursions will have come on again. Would it not be well if the Councils of Societies organized their arrangements with a view to some practical ends?

In the districts of crystalline and metamorphic rocks, examples of transitional states bearing on the great origin-of-granite question might be designated as one of the topics of inquiry, and members solicited to search for and study examples, and to send notices of them to the Societies before the excursions were decided upon. In the districts of the Secondary rocks, examples of unconformability and thinning out, and the intercalation of special deposits, would also form a most valuable subject of inquiry.

Palæontology, as such, should not be neglected: and by selecting given genera or families of fish, mammals, or mollusca, and tracing the ranges of species upwards and downwards stratigraphically through the separate beds of the various deposits of any geological formation or formations, the most valuable data for geological progress would be obtained; and contemporaneously with this investigation, another, devoted to the geographical extent at each horizon of the same species, should also be carried on.

In the districts affected by the late earthquake the directions so intelligently given by Mr. Mallet might be taken as the guide to local inquiry, and many details accumulated.

More especially we would urge that as much impetus as possible should be given to fossil botany. It is a department sadly neglected, and nevertheless most useful and most important in the acquirement of a correct knowledge of the ancient history of our planet. In the mining districts further experiments on internal heat are greatly to be desired.

We do not submit to the Provincial Societies the organization of special subjects for investigation during these excursions, but the detailing to the members of certain subjects for individual study and attention, and to get from the working members who take such subjects up reports of their progress, and the details of the most interesting examples and results; and then upon these reports to select the places for, and the routes of excursions, making the principal or most competent of the working members the *duces* on these occasions. We think that by such preliminary steps the excursions would be made much more instructive, more pleasurable, and certainly more beneficial to science.

ON HELIX, AND PERFORATED LIMESTONE.

By Miss E. Hodgson.

A few months ago I sent to the British Museum a block of mountain limestone, perforated into deep cells by mollusks. It was met with on a limestone ridge three miles south-west of Ulverston, and first attracted notice by being brought to town to be employed for building purposes.

The perforations were found to be on the under-side of a projecting ledge, and were large enough for the fingers to be introduced upwards to the depth, in some, of three inches, the diameter being about seven-eighths of an inch. They were inhabited, at the time of the discovery (August), by the land-snails *Helix nemoralis* and *Helix concinna.*

Mr. Woodward, on receiving the stone, very kindly sent for my perusal a 'Memoir on Perforations by Helices in the Calcareous Rocks of the Boulonnais,' by M. Bouchard-Chantereaux. In this memoir the author states his belief that the cells are the work of

Helices, and that the eroding action is performed by the foot, with the aid of an acid secretion.

Ever since I became familiar with the microscopic structure of the tongue of Helix, etc., I have always believed that it was so constructed for purposes of abrasion, either of stone or other hard substances; but I was not previously aware that the land-snails were, any of them, supposed to form for themselves hollowed, hybernating chambers in rocks. That they do consume the limestone no one who has seen the above memoir can doubt; the only thing not so evident is the way it is done and the purpose for its being done.

Finding some individuals of *Helix aspersa* under a stone in a hybernating state, I had the stone and all carefully placed under a bell-glass in a warm room, leaving sufficient space under the edge of the glass for air. The following morning all had burst the epiphragm and shifted their position. In another day they were all upon the glass, in full activity, crawling about. On examining the under-side of the head through the bell-glass with a lens, no tongue was visible, but on smearing the glass with the juices of bruised geranium leaves, the tongue protruded itself, making strokes upon the glass at the rate of about one in three or four seconds. I then scraped a piece of limestone with a pen-knife upon a sheet of paper, and moistened the scrapings into a paste with distilled water, and then smeared the inside of the glass with the paper. The action of the tongue hitherto had been sluggish and not continuous, but the instant the head came in contact with the lime the action quickened. Flake after flake was removed from the glass and taken into the crescent-shaped mouth. The tongue appeared to be used nearly in the same way as that of the pond-snail when it is taking off the green film from the sides of the aquarium; that, however, is accompanied by a clear, ringing sound, doubtless owing to the necessary force used. In Helix the tongue is curved outwards and first pressed momentarily, more or less flat, against the glass, the next instant it becomes channeled or spoon-shaped, and in this form is withdrawn, the concave side uppermost. I have no doubt, however, on a dry substance, one not so slippery as glass, that the flat application would be prolonged, and more muscular force exerted,—indeed I have occasionally observed a slight jerk of the head as the tongue left the glass, indicating greater power of stroke.

On subsequently trying *Helix nemoralis*, it swallowed the lime with the same avidity, and both worked at it, with short intervals of rest, for hours and day after day. In both species a little wave of moisture is driven before the head, extending beyond it about the fiftieth part of an inch; but the tongue appears to be drier in *H. nemoralis* than in *H. aspersa*, although I think the amount of fluid varies in both. When the animal is merely gliding along, and not using the tongue, a little bubble of fluid is constantly, at short intervals, emitted from the mouth, which partially opens for the purpose. I have repeatedly saturated strips of litmus paper in this fluid, both at the head and all along the foot, but have entirely failed to detect any pink colouring denoting the presence of an acid.

When the tongue is being withdrawn into the mouth it does not seem to touch the upper jaw, but has full time to be withdrawn before the upper jaw closes; indeed it does not seem to close entirely, the downward movement appears to be more connected with the action of swallowing than made for the purpose of meeting the tongue. On putting a little water to the animal, of which it seems to be very fond, the drinking action is seen to be different. I do not think the tongue is protruded, but there is a rapid movement of the whole mouth until the supply fails, when the tongue again comes into play.

Desirous of witnessing the usual mode of feeding, I placed some slices of the fronds of *Asplenium marinum* on the glass. The *H. aspersa* attacked and devoured this very greedily. It was curious to watch the upper jaw, before so inactive, now making such strenuous efforts to get it into the mouth; the latter was distended to a gape, displaying the interior brown ribs of the roof and its projecting marginal teeth; the tongue, when I could see it for the fern, was actively assisting. It was a very awkward process, the piece being too big and difficult to manage.

From these observations it appears certain that the mouth has two distinct actions—the licking and the biting action. It also appears equally certain that lime is needful to the animal, and is taken in the same way as food; from which I infer that the Helices, when they are occupying the cells in the limestone rocks, abrade the walls with the tongue for the purpose of getting the lime (and that they hold this instinct in common with the rest of their species), hence the irregularity, dissimilarity, deformity of those cells much frequented by them; but that the original cellular form of the erosion is due to some marine mollusk of the Glacial period.

A HELP TO THE IDENTIFICATION OF FOSSIL BIVALVE SHELLS.

By Harry Seeley, F.G.S.,

Woodwardian Museum, Cambridge.

Lamellibranchiate shells are the most abundant fossils of most rocks. Numerous in genera, and prolific in species, they are multitudinous in individuals, and the specimens vary. The study is not easy. It has little of the poetry of many other branches of natural history, and has naturally received less attention. But in each subkingdom specially, no less than in the animal kingdom generally, the law holds good that the lower the organization the longer is the duration in time. And so, important as the higher mollusca are in the analysis of rocks into their several zones, it is on the lower forms we rely in synthetical arrangements. The Conchifera readily divide rocks into Palæozoic and Neozoic,—no form with a pallial sinus being known below the Lower Secondary strata; while, from the appearance in them of numerous new genera, no class of animals better marks the recognized systems into which fossiliferous rocks are grouped. It is indispensable both to the geologist and biologist to be familiar with the genera, and it is the object of this paper to render the principles on which they are identified more easy and exact.

That genera are *practically* realities every student knows well; as such the geologist and zoologist have to do with them. And it has elsewhere* been shown that between hosts of groups intermediate forms can no more be found, than can intermediate wood fill the space between the forked branches of a bush. Accepting the fact, the question arises,—How may genera be known? The distinctive characters depend on the definition of a genus adopted. If it is merely a number of nearly-related species, then the descriptive characters will include those in the whole of the forms; but if it exists independently of the species, being fundamental to them, then the specific characters cannot enter into the description of the genus. Practically this latter view, which is adopted in the paper referred to, reduces the description to a sixth of the shortest customary length, while the distinction becomes clearer by pruning away much that is common to other types. But even these characters are often needlessly redundant, and several common to nearly-allied groups may be cancelled.

Having in this spirit examined an extensive series of Lamellibranch shells in preparing for a course of lectures, given three years ago, I found in most cases the hinge-characters among the most important residua so gotten; and shortly after, while determining some casts of fossils in which the hinge-teeth were the only generic characters seen, it occurred to me to write the teeth down in formulæ like those used for the teeth of mammalia. Subsequent re-examination of specimens showed that in a large majority of cases these hinge-formulæ were almost the only characters with which the student need be troubled; and believing that it will not be found altogether useless, the following list has been made of the more common and remarkable forms, and arranged for facility of reference.

The teeth sometimes vary much in the same genus,—one Cardium, for instance, showing twelve teeth, and another not more than six, though rudiments of the other six may generally be found; and occasionally the hinge is toothless, the teeth becoming obliterated with age. The constant teeth are notated in ordinary numerals;

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* 'Researches on the Homologies of the Bivalve Mollusca; and therein of the Law of Variation of Forms, and the Nature of Genera,' Part 1, communicated to the Cambridge Philosophical Society, March 17, 1862, and remaining unpublished, pending completion. The formulæ used in this paper were then explained in a note.

while the variable ones, which sometimes may be as large as the others, and are sometimes scarcely to be found, have a line or dot above the numerals to indicate that they are subordinate. Teeth are often cleft a little, and sometimes look like two, so that it is occasionally convenient to indicate them in the formula, which is done by writing a small figure ^{2} above the numeral, as though it were raised to the second power.

Rarely teeth are anchylosed, but, excepting Isocardia, only under the umbones, and then only at their outer edges, forming an inverted V shape, which is indicated by a small figure ^{1} placed above the numeral 2.

Typically, teeth are in three groups: those under the umbo, called umbonal; those near the front adductor muscle, called anterior; and those under the ligament, called posterior. These two latter groups are often elongated latitudinally, and when this is the case have a small *l* added to distinguish them from the ordinary conical forms.

The spaces between the groups of teeth on each side of the umbo are generally equal, and such spaces are marked by a single dot placed midway between them. To indicate a longer distance, two dots may be put one after the other, and a very short one is marked by two dots one above another.

For a cartilage-pit the letter F is used (abbreviation of *fossa*), and where a tooth has the letter *f* above it, the tooth supports the cartilage, as in Mya, etc.

The sign + means many; it is chiefly used to indicate the numerous teeth of the Arca tribe. The straight line running between the numerals marks the plane dividing the valves. The letter S is an abbreviation for "with a pallial sinus;" L, for lunule; E, with an escutcheon; O, with an ossicle; M, massive; and Q, quadrate.

The teeth are read from left to right, the posterior end being to the right,—so that the lower valve is *not* the left.

As an illustration of the way these symbols are used, an example or two may be cited.

TRIGONIA.—Here there are in the lower valve two teeth under the umbo, and no anterior teeth, so the number 2 is written under a line and with a dot on each side to show that the teeth are umbonal, thus $\frac{}{\cdot 2 \cdot}$. Then in the upper valve there is on the left a single tooth, and to the right of it two anchylosed; and as these are under the umbo, they, too, are written with the dot on each side, thus: $\frac{\cdot 1 : 2^1 \cdot}{}$. Putting these valves together, the generic characters for Trigonia will be $\frac{\cdot 1 : 2^1 \cdot}{\cdot \quad 2 \quad \cdot}$, and as no other genus has teeth quite like it, obviously no other character need be mentioned. It is found convenient, in remembering these formulæ, to prefix the initial letter of the genus.

CRASSATELLA.—Here the upper valve has two teeth and a cartilage-pit under the umbo, and posteriorly one tooth; so the dentition will be $\frac{\cdot 2 : F \cdot 1}{}$. And in the lower valve under the umbo are two teeth and a little subordinate one (constant however), and the cartilage-pit; its formula will therefore be $\frac{}{\cdot 2\,\underline{1}\,F\cdot}$. Putting the valves together, $\frac{\cdot 2\,F\,.\,1}{\cdot 2\,\underline{1}\,F\cdot}$, will be the generic character for Crassatella; and no other genus has a like hinge.

LIST OF GENERIC FORMULÆ.

Types with a single Cartilage under the Umbo : F.

Anomia . $\frac{\cdot F\cdot}{\cdot F\cdot}$; with four central muscular impressions.

Ostrea . . $\frac{\cdot F\cdot}{\cdot F\cdot}$; attached.

Lima . . . $\frac{\cdot F\cdot}{\cdot F\cdot}$; axis anteriorly inclined to a straight hinge line.*

Pecten . . $\frac{\cdot F\cdot}{\cdot F\cdot}$; axis perpendicular to a straight hinge line.

Mya . . . $\frac{\cdot 1^{f}\cdot}{\cdot F\cdot}$; S.

Tugonia . $\frac{\cdot 1^{f}\cdot}{\cdot 1^{f}\cdot}$; S.

§ *With an Ossicle in the Cartilage: O.*

Thracia . $\frac{\cdot F\cdot}{\cdot F\cdot}$; O; S.

Anatina . $\frac{\cdot 1^{f}\cdot}{\cdot 1^{f}\cdot}$; O; S.

Types with Teeth in addition to the Cartilage.

Chamostrea $\frac{1\cdot F\cdot}{1\cdot F\cdot}$; O.

Avicula . $\frac{1\cdot F\cdot \bar{1}^{l}}{1\cdot F\cdot \underline{1}^{l}}$

Anapa . . $\frac{1\cdot 1^{f}\cdot 1}{1\cdot 1^{f}\cdot 1}$

Ervilia . . $\frac{\cdot 1\,F\,1\cdot}{\cdot 1\,F\,1\cdot}$

Plicatula . $\frac{\cdot 1\,F\,1\cdot}{\cdot 1 : F : 1\cdot}$; attached.

Spondylus $\frac{\cdot 1\,F\,1\cdot}{\cdot 1 : F : 1\cdot}$; umbo of attached valve receding with age.

Gnathodon $\frac{2\cdot F\cdot 1}{3\cdot F\cdot 2}$; S.

Cardinia . $\frac{\bar{1}\cdot F\cdot 1}{1\cdot \underline{1}\,F\cdot \underline{1}}$

Mesodesma $\frac{1\cdot 1\,F\cdot 1}{\underline{2}\cdot 1\underline{1}\,F\cdot 1}$; S.

Crassatella $\frac{\cdot 2\,F\cdot 1}{\cdot 2\,\underline{1}\,F\cdot}$; L.

Lutraria . $\frac{\cdot \bar{1}\,1^{2}\,\bar{1}\,F\cdot}{\cdot 2^{1}\,F\cdot}$; S.

Mactra . $\frac{2^{l}\cdot 2^{1}\,F\cdot 2^{l}}{2^{l}\cdot 2^{1}\,F\cdot 2^{l}}$; S.

Codakia . $\frac{2\cdot 2\,F\cdot 1}{1\cdot 2\,F\cdot 1}$.

Scrobicularia $\frac{\cdot 2\,F\,\bar{1}\cdot 1}{\underline{1}\cdot 1\underline{1}\,F\,1\cdot}$; S.

Semele . . $\frac{1\cdot \bar{2}\,F\cdot 1}{1\cdot 2\,F\cdot 1}$

Ungulina $\frac{\cdot 2\,\bar{F}\cdot}{\cdot 2\,F\cdot}$

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* The direction of the axis might be marked by a line; thus, Lima /; Pecten |; Avicula \\.

Types with many Cartilage-pits.

Gervilia . $\frac{\cdot F^{Q}\cdot\cdot +}{\cdot F^{Q}\cdot\cdot +}$

Perna* . $\frac{F:+}{F:+}$

Types with numerous Parallel Teeth.

Macrodon $\frac{(1:+^{l}1:+)\cdot 1^{l}}{(1:+^{l}1:+)\cdot 1^{l}}$

Arca . . . $\frac{1:+}{1:+}$; hinge straight.

Cucullæa $\frac{1:+^{l}\cdot 1:+\cdot 1:+^{l}}{1:+^{l}\cdot 1:+\cdot 1:+^{l}}$; muscles margined by lamellæ.

Pectunculus $\frac{1:+}{1:+}$; hinge crescentic.

Limopsis . $\frac{1:+F\cdot 1:+}{1:+F\cdot 1:+}$

Nucula† . $\frac{1:+\cdot F\cdot 1:+}{1:+\cdot F\cdot 1:+}$; hinge sharply angular at F.

Nuculina $\frac{1:+\cdot\cdot 1^{l}}{1:+\cdot\cdot 1^{l}}$; hinge angular.

Leda . . . $\frac{1:+\cdot F\cdot 1:+}{1:+\cdot F\cdot 1:+}$; S.

Solenella $\frac{1:+\cdot\cdot 1:+}{1:+\cdot\cdot 1:+}$; S.

Types with few Teeth under the Umbo.

Chama . . $\frac{\cdot 1\bar{1}\cdot}{\cdot 1\cdot}$

Pholadomya $\frac{\cdot \bar{1}\cdot}{\cdot \underline{1}\cdot}$

Iphigenia . $\frac{\cdot 1^{2}\cdot}{\cdot 1^{2}\cdot}$

Psammobia $\frac{\cdot 1\cdot}{\cdot 2\cdot}$; S.

Astarte . $\frac{\cdot 2\cdot}{\cdot 1\cdot}$; L.

Opis . . . $\frac{\cdot 2\cdot}{\cdot 1\cdot}$; L; keeled.

Pachyrisma ·· M $\left(\frac{\cdot 1\cdot}{\cdot \bar{1}1\cdot}\right)$

Gastrana. $\frac{\cdot 1^{2}\cdot}{\cdot 2\cdot}$; S.

Capsula . $\frac{1^{2}:1\cdot}{\cdot 1:1^{2}\cdot}$; S.

Sanguinolaria $\frac{\cdot 2\cdot}{\cdot 2\cdot}$; S.

Pharus . . $\frac{\cdot 2\cdot}{\cdot 1:1^{2}\cdot}$; S.

Solecurtus $\frac{\cdot 2\cdot}{\cdot 2\cdot}$; S; both ends gaping.

Saxicava . . $\frac{\cdot 2\cdot}{\cdot 2\cdot}$

Diplodonta $\frac{\cdot 1^{2}:1\cdot}{\cdot 1:1^{2}\cdot}$

Venericardia $\frac{\cdot 2\cdot}{\cdot \underline{1}1\underline{1}\cdot}$

Trigonia . $\frac{\cdot 1:2^{1}\cdot}{\cdot 2\cdot}$

Lucinopsis $\frac{\cdot 1:1^{2}:1\cdot}{\cdot 2\cdot}$; S.

Circe . . . $\frac{\cdot 3\cdot}{\cdot 3\cdot}$; L.

Venus . . $\frac{\cdot 3\cdot}{\cdot 3\cdot}$; L; S.

Tapes . . $\frac{\cdot 3\cdot}{\cdot 3\cdot}$; S.

Glaucomya $\frac{\cdot 3\cdot}{\cdot 2:1^{2}\cdot}$; S.

Saxidomus $\frac{\cdot 3\cdot}{\cdot 4\cdot}$; S.

Cytherea $\frac{\cdot 4\cdot}{\cdot \underline{2}3\cdot}$; L; S.

Artemis $\frac{\cdot 4\cdot}{\cdot \underline{2}3\cdot}$; L; S; orbicular; sinus an elongated cone.

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* In this genus should be included all the fossil species called Inoceramus, excepting perhaps *I. involutus*, which may be left as a critical subtype, having much the same relation with Perna that Janira has with Pecten.

† The Palæozoic species of Nucula and Leda have external ligaments, and are regarded by authors as then forming one genus, which is named Ctenodonta.

Types with Umbonal and Posterior Teeth.

Panopæa.	$\frac{\cdot 1 \cdot 1^{lq}}{\cdot 1 \cdot 1^{lq}}$
Margaritina	$\frac{\cdot 1 \cdot 2}{\cdot 1 \cdot 1}$
Hippopus	$\frac{\cdot 1 \cdot 2}{\cdot 1 \cdot 2}$
Tridacna.	$\frac{\cdot 1\bar{1} \cdot 1\bar{1}}{\cdot 1 \cdot 2}$; lunule perforate.
Ensis* . .	$\frac{1 \cdot 2}{1 \cdot 2}$; S.
Solen . .	$\frac{\cdot 2 \cdot 1}{\cdot 1 \cdot 1}$; S; umbones terminal.
Cultellus	$\frac{\cdot 2 \cdot 1}{\cdot 1 \cdot 1}$; S.
Machera.	$\frac{\cdot 2 \cdot 1}{\cdot 1 \cdot 1}$; S; from umbo to base runs an internal rib.
Tancredia	$\frac{\cdot 2 \cdot 1^{l}}{\cdot 2 \cdot 1^{l}}$
Castalia .	$\frac{\cdot 2 \cdot 1}{\cdot 1 \cdot 2}$
Unio . . .	$\frac{\cdot 2 \cdot 2^{l}}{\cdot \underline{1}\,1 \cdot 1^{l}}$
Cyprina .	$\frac{3 \cdot \bar{1}}{\underline{1}\,3\,\underline{1} \cdot 1}$

Types with Anterior and other kinds of Teeth.

Cardita .	$\frac{\bar{1} \cdot 1 \cdot 1^{l}}{\underline{1} \cdot 1^{l} \cdot \underline{1}^{l}}$
Kellia . .	$\frac{1^{l} \cdot 1 \cdot 1^{l}}{(\underline{1}\,1)^{l} \cdot 1 \cdot (1\,\underline{1})^{l}}$
Isocardia	$\frac{(1 \cdot 1)^{1l} : 1^{l} \cdot 1^{l}}{1 : (1 \cdot 1)^{1l} \cdot 1^{l}\,\underline{1}}$
Cardium.	$\frac{1\,\bar{1} \cdot 1\,\bar{1} \cdot 1\,\bar{1}}{\underline{1}\,1 \cdot \underline{1}\,1 \cdot \underline{1}\,1}$
Tellina . .	$\frac{\bar{1} \cdot 1^{2}\,\bar{1} \cdot \cdot 1}{1 \cdot 1\,1^{2} \cdot \cdot 1}$; S.
Galatea .	$\frac{1 \cdot \quad \cdot 1}{\underline{1} \cdot 2^{1} \cdot \underline{1}}$; S.
Donax . .	$\frac{1 \cdot 2 \cdot 1}{\underline{1} \cdot 2^{1} . \underline{1}}$; S.
Lucina . .	$\frac{1 \cdot 2 \cdot 1}{1 \cdot \bar{2} \cdot \bar{1}}$; L; S.
Corbis . .	$\frac{1 \cdot 2 \cdot 1}{1 \cdot 2 \cdot 1}$; margins crenulated.
Cyclas . .	$\frac{1 \cdot 2^{1} \cdot 1}{1 \cdot 2 \cdot 1}$
Cyrena .	$\frac{1 \cdot 3 \cdot 1}{\underline{1}\,1 \cdot 3 \cdot 1\,\underline{1}}$
Corbicula	$\frac{1^{l} \cdot 3 \cdot 1^{l}}{(\underline{1}\,1)^{l} \cdot 3 \cdot (1\,\underline{1})^{l}}$
Trigona .	$\frac{1 \cdot 3 \cdot}{\underline{1}\,1 \cdot 3 \cdot \underline{1}}$; S.
Meroë . .	$\frac{1 \cdot 3 \cdot}{\underline{1}\,1^{l} \cdot 3 \cdot}$; L; E; S.

Many of the formulæ will be found unsatisfactory, no doubt; for it has not been my object either to give a synopsis of bivalve genera or of generic characters, but merely to illustrate the features and capabilities for distinctive purposes of some remarkable mystical structures. Yet I would ask the student who takes some member of one of the larger types, say Donax, Tellina, Cardium, or whatever it may be, and fails to torture its hinge into agreement with the formula, fairly to ask,—What a genus really is? Unless I mistake, facts are as faulty as the formulæ. This, however, involves the whole question of the nature and origin of genera, which will shortly be treated in full elsewhere.

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* A form like this is not introduced as a genus, but merely as an illustration of results arrived at by adhering to the formulæ rigidly.

These characters ought never to supersede descriptions, but should rather be superadded. And it is suggested that, henceforth, definitions might be made more sure if the dental formula were given with each new species or genus described. And, by way of illustration, annexed is a notice of the new genus Atalanta.

Atalanta has but one species, and is founded on the *Astarte Hartwelliensis* of Sowerby. Observing on it a posterior area like that in Cyprina, and which also occurs in some species of Astarte, which show rudiments of lateral teeth, I was led to suspect that if this shell were an Astarte at all, it also might have lateral teeth. Accordingly, as there was no lack of specimens, I broke up many examples, and succeeded in finding the hinge, which is $\frac{1^l \cdot 2 \cdot 1^l}{(1\,1)^l \cdot 1 \cdot 1^l}$; thus differing from Astarte in having on each side well-developed lateral teeth. The long teeth give it a certain resemblance to Corbicula or Mactra, which it also resembles in having the lateral teeth transversely striated with age. The ligament is short, but very prominent. The pallial line was not to be traced. Astarte is probably its nearest relative.

FOSSIL BIRDS.

By the Editor.

(*Continued from page* 24.)

We shall, we trust, be pardoned for returning in this number, before we proceed onwards to Cuvier's works, to some omissions of old authors which have occurred.

The first of these additional quotations is from Scheuchzer's later work, published at Zurich in 1718, 'Meteorologia et Oryctographia Helvetica,' p. 336.

"Diluvian Birds.—Everybody can very easily conceive that all the birds, owing to their agility, could have escaped the waters of the Deluge, and it is therefore not to be wondered that even in the richest and best-assorted museums of arts and natural history, remains of the bird-kind are very seldom to be met with, or that they are, so to say, scarcer than a white raven. In Switzerland I have as yet found nothing; from the quarry of Oeningen I can show a well-impressed bird's feather, which I have reproduced on page 14 of the Querel. Pisc." This figure we give in our Plate IV. fig. 1.

The original passage follows below:—

"Aves Diluvianæ.—Es kan ein jeder ohnschwer begreifen, dass die Vögel, wegen ihrer Leichte, alle werden in denen Sündfluth-Wassern oben aufgeschwummen seyn, und sich desshalb nicht zu verwundern, wann auch in denen best-versehenen Kunst- und Naturalien-Kammern etwas von dem Vogel-Geschlecht überbliebenes so seltsam oder noch rarer ist als ein weisser Rab. In denen Schweitzerischen Landen habe noch nichts gefunden; aus den Oeningischen Steinbruch aber kan ich zeigen eine wol ausgedruckte Vogelfeder, welche habe abbilden lassen in Querel. Pisc. p. 14."

Volkmann, in 1720, published his 'Silesia Subterranea,' at Leipzig. In it he says:—

"§ VI. All these phases are common also with birds, insects, worms, and vermin. Mylius, in his Memor. Sax. Subterr. pl. i. relat. vi. p. 47, records a hen, which was discovered a few years ago in the quarries of Illmenau, and which he exhibits on plate iv. n. i. p. 74, such as it is to be seen in the stone.—Baccius reports in his 'Thermis,' lib. v. c. 4, fol. 282, having seen a petrified hen together with her eggs, discovered in a salt-pit.—Valvasor, according to what he says in his description of the principality of Crain (die Ehre des Herzogthums Crain), lib. iv. c. 2, p. 478, discovered near Landespreis, in a ditch, on the mountain, amongst many sea-shells and other petrefactions, a bird's nest with a small bird sitting on four eggs, which he presented to M. Henry Garbusat, at Lyons, in France.—Büttner exhibits in l. c. tab. xxi. p. 218, a bird's nest, containing four or five eggs, like quail-eggs, in a stone, four yards in circumference, discovered at Kindelbruck, and he mentions also in the same place, that in the same tufa bluish eggs, like ducks' eggs, have been discovered, which, when the shell was opened, the white and the yolk were quite distinctly to be seen, but *rather hard*. Near Vienna it is said a quarry exists where petrified birds, tongues and beaks of eagles, and other petrefacta are to be found.—Scheuchzer in his Querel. et Vindic. Piscium, represents in plate 11, a beam- or tail-feather from Oeningen. At Bottendorff, and on the Kuntzel lake, there are, according to Mylius, l. c. p. 13, slate-stones containing birds and beaks, to be found," etc. etc.

We give the original:—

"§ VI. Alle diese *fata* haben auch die Vögel, Insecta, Gewürme und Ungeziefer gehabt. Mylius, in s. Memor. Sax. Subterr. pl. i. relat. iv. p. 47, gedencket einer Henne, die vor wenigen Jahren in einer Berg-Nieren in dem Illmenauer Berg-Werck gefunden worden, welche Er tab. iv. *sub num.* i. p. 74, wie sie in dem Steine zu sehen im Kupffer vorgestellt. Baccius, de Thermis, lib. v. c. 4. *fol.* 282, erzehlet, dass Er eine versteinerte Henne mit Eyern gesehen, die man in den Salz-Gruben gefunden. T. Weichard Valvasor hat (davon Er in der Ehre des Herzogthums Crain, lib. iv. c. 2, p. 478, gedacht) bey Landes-Preis über dem Berge in einem Graben nebst vielen Meer-Muscheln und anderen versteinerten Stücken ein Vogel-Nest mit einem kleinen auf den Eyern sitzenden Vogel angetroffen, welches Er dem Mons. Henry Garbusat nach Lyon in Franckreich geschickt. Büttnerus, l. c. weiset in der XXI. Tab. *ad p.* 218, ein versteinertes Vogel-Nest, darinnen 4 oder 5, weisse Eyer gelegen, den Wachtel-Eyern gleich, in einem Gestein, das 4 Ellen starck gewesen, von Kindelbruck, und *pag. ead.* meldet Er, dass eben in diesem *Topho* man ehemals blaulichte Eyer den Enten-Eyern gleich gefunden, darinnen als man sie zerstupfet, die Schale, das Weisse und Dotter wohl zu unterscheiden gewesen, aber alles sehr verhärtet. Hinter Wien soll ein Steinbruck seyn, worinnen man petrificirte Vögel, auch Zungen und Schnäbel von Adlern und andern Vögeln im Gestein sieht. Scheuchzer in s. Querel. et Vindic. Piscium stellt in der 11. Tab. eines Vogels Schwing- oder Schwantz-Feder in einem Schiefer-Stein von Oeningen vor Augen. Zu Bottendorff und Küntzel-See brechen nach Mylii Bericht, l. c. p. 13, Schiefer-Steine mit Vögeln und Bienen," etc. etc.

Baier, 1722, says in his 'Fossilia Diluvii Universalis Monumenta,'* page 20:—

"§ XII. Of the winged kind there have been but very few fossil remains discovered as yet, but they are not therefore to be undervalued. Joh. Dan. Major, in his Dissertat. Epist. de Cancris et Serp. Petrefact. § 47, p. 38, quotes amongst the animal remains of the mountains, and in the middle of solid marbles, *beaks of birds*, but he mentions no authority, neither does he give any figures; he is, however, himself a serious and a trustworthy writer. Cl. Scheuchzer, in his Quer. et Vindic. Piscium, tab. ii., shows a *tail of a bird or rowing-feather in a fossil stone at Oeningen, the only specimen of the remains of the winged genus known as yet*, except the gallinaceous bird quoted by *Agricola*, lib. x. foss. cap. xv., and truly, this author quotes many fowls in fossil-stone discovered in the forest of Hercynia, and he does not only proclaim highly the magnitude and the disposition of all the organic parts of the bird transferred to the stone, but also the very lineaments of minor form imprinted by the mineral juice. Such a hen discovered in the stone-quarries of Henneberg, in Saxony, is described by *Mylius* in his Saxon. Subterr. relat. vi. et x. p. 74, fig. 2. Be it as it may, for greater certitude the laborious Buttner, p. 218, describes thus the birds'-nests and eggs discovered in the tufa-quarries of Thuringia, and which deserve notice."

We append the original passage:—

"§ XII. *Ex volucrum* genere pauca oppido fossilia adhuc in conspectum venerunt, sed tamen minime contemnenda. Joh. Dan. Major, in Dissert. Epistol. de Cancris et Serp. Petref. § 47, p. 38, inter partes animalium, quæ in intimis sæpe montium visceribus, imo mediis marmorum solidorum corporibus, repertæ sunt, connumerat *rostra avium*, sed nullo auctore aut exemplo speciali nominato. Gravis tamen ipse scriptor est et fide dignus. Cl. Scheuchzerus, in Quer. et. Vindic. Piscium, t. ii. exhibet *caudæ avis vel remigem pennam in lapide fissili Oningensi conspicuam, unicum quod hactenus sit cognitum ex volucrium regno superstes monumentum*, excepto *Gallo Gallinaceo*, cujus meminit *Agricola*, lib. x. foss. cap. xv. Verum hic *Gallos Gallinaceos* ponit, tanquam plures in lapide fissili Hercyniæ Sylvæ expressos, neque satis declarat, utrum vera magnitudine et partium organica dispositione avem referat lapis, an sola lineamenta minoris formæ, a succi mineralis ramulis utcunque efficta; cujusmodi gallinam in saxo fodinarum Hennebergicarum depictam exhibet *Mylii* Saxon. Subterr.

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* Brit. Mus. 458. a. 14. "Q. D. B. V. Fossilia Diluvii Universalis Monumenta, præside Johanne Gulielmo Baiero S. Theol. D. et P. P. eruditis excutienda sistet a.d. 19 Martii A. R. S. ciɔl. sec. xii. Georg. Christoph. Eichler, Norimbergensis. Altorfl. Noricorum, 1725."

relat. vi. et x. p. 74. fig. 2. Quicquid horum sit, majori certitudine diligentissimus Buttnerus, p. 218, avium nidos et ova in Thuringiæ lapicidina tofacea inventa his verbis notatu dignis allegat: *Ich bekomme nochmahlige Versicherung,*" etc.

MYTILUS SPATHULATUS, A NEW CRETACEOUS SPECIES.

By H. Seeley, F.G.S.

A flint cast of a Mytilus has been obtained from the gravel of Barnwell, near Cambridge, by Mr. Percevall, B.A., Trin. Hall, and entrusted to me for description.

Form elongated and narrow, attenuated anteriorly, with valves deep, and longitudinally striated. The anterior outline of the lips is straight, that of the posterior side a gentle curve, which is somewhat straightened towards the apex. The shell is about three times and a half as long as wide, and widest below the middle. The lateral outline of the valves is lanceolate, the greatest height being in the anterior third.

From the umbones the [subacute] line of inflation ascends, and curves posteriorly, so as to overhang the hinge. It then becomes rounded, and curves into the middle of the shell. The sides descend from it nearly straight. So, on the anterior side of the umbonal end, the sides slope somewhat away from the lips, penthouse-like; while on the posterior side they slope somewhat together, forming a shallow trough. The height of the shell is more than twice its transverse diameter.

The whole is marked with numerous, close, very fine, longitudinal striæ, which appear to be crossed by fine striæ, coincident with the lines of growth, but wider apart. The lips are dentated.

This remarkable form, the first Mytilus yet noticed from the English chalk, must have had a very thin shell, since the faintest exterior ornament seems all preserved on the flint cast.

It is constricted at intervals by rugose bands of growth.

The high valves, laterally compressed form, straight anterior side, and very compressed umbonal end, will readily distinguish this from every other striated cretaceous species. All the forms yet observed in the chalk are striated.

CORRESPONDENCE.

Spiral Planetary Orbits.

Dear Sir,—As a regular subscriber to the 'Geologist,' and one interested in its success, I doubt not you will pardon me for a few remarks upon your editorial articles in the last two numbers.

There are certain views put forward which, unless I am mistaken, are opposed to the known facts of physical astronomy, and although my mathematics are rather rusty, I think I am justified in the following criticisms. At p. 442 you speak of effects which changes in the sun's mass would produce in its attraction upon the earth. But would not any matter either dissipated from or deposited on the sun, continue to attract the earth equally before and after dissipation or deposition, the centre of attraction being in every case the centre of gravity of that matter the sun and the earth, and the whole quantity of matter continuing constant. Nor can it be supposed that the position of the centre of gravity could be sensibly altered by such changes.

At p. 443 you refer to Tyndall's expression that the moon "skids the earth." He is considering her tide-generating influence, and shows that she must retard the earth's *rotation*, but you have spoken, unintentionally no doubt, as if this action had an effect on the orbital motion. Now it is a well-known principle of mechanics, that the motions of rotation and translation are independent of each other; although they may have been originally both given by the same impulse.

Unless I am wrong, there is a mistaken idea which runs through portions of your articles in Nos. 72, 73. You appear to suggest that with a larger extent of orbit there would be greater velocity of the earth in her orbit, and that the effect of a diminished orbit through the action of a resisting medium would be to lessen the velocity in the orbit. One passage in which this idea is presented is this, "if we consider the effects of a higher orbital velocity, we shall find it would give rise probably to a larger extent of orbit."

Now it is usually considered (I may say proved) that the reverse is the case. This may be deduced from Kepler's third law, that the squares of the periodic times of the planets are proportional to the cubes of their mean distances,—a law which is proved, from mechanical considerations, to be true of *all* cases of planetary motion.

Suppose, for simplicity's sake, that the orbit may be considered a circle for one revolution, which, with the rarity of the cosmical ether and smallness of the ellipticity, is sufficiently true for the purpose.

Expressed symbolically, let T be the periodic time; a, mean distance:

$$\therefore T^2 \propto a^3$$

But in the case of a circular orbit, the velocity (V) is constant:

$$\therefore TV = 2\pi a$$

$$T = \frac{2\pi a}{V}$$

$$\therefore \left(\frac{2\pi a}{V}\right)^2 \propto a^3$$

$$\therefore V \propto \frac{1}{\sqrt{a}}$$

∴ As the distance of a planet from the sun is increased, the velocity in the orbit will be diminished, and *vice versâ.*

Hence, paradoxical as it might appear, the effect of a resisting medium by causing the planets to fall towards the sun, and so diminishing their mean distances, is to increase the orbital motion of the heavenly bodies (*vide* Pratt's 'Mechanical Philosophy,' p. 600). Any changes of the velocity of rotation would be wholly independent of these effects.

Believe me, my dear Sir, faithfully yours,

O. Fisher.

Elmstead, Colchester, 2nd January, 1864.

Mammalian and Cave Relics.

My dear Sir,—Although far enough from "Grays Thurrock," I could wish Dr. Falconer could look over my specimens of "mammalian fauna" collected in the caves here. Besides that cave on which a paper was read by me at Oxford, and where Dr. Falconer showed me the kind attention of an older student of geology, and another cave, of which an account was read in my name at the Cambridge meeting, I have this summer met with a third cave containing the usual remains, mixed with the same flint-chips, and opened another barrow in that locality in which these latter specimens occur.

By the way, I do not think a very curious notice of flint-chips which I discovered in my professional reading has yet appeared in print, except from my pen, and where it was not likely to come before students of science. Most are aware that in the 5th chapter of Joshua, verses 2 and 3, mention is made of "the knives of flint," with which he re-circumcised the children of Israel; but I do not think the following record is patent, because it occurs only in the Septuagint, which often *enlarges* on matters only briefly noticed in the Hebrew text. In Joshua xxiv. 30, it is written, "And they buried Joshua in the border of his inheritance, and *they placed with him in his tomb* (query a tumulus?) *the flint-knives with which he had circumcised the children of Israel; and there they are unto this day.*" The italics show the Septuagintal amplification of the Hebrew text.

It is impossible not to put "this and that together,"—I mean the chips in our tumuli and his,—and not to speculate upon the *possible* fact that religious rites had to do with the interments of these, and no other implements. I by no means would say I think it was so; but the fact is the parent of the thought. I wish Dr. Falconer could inspect my collection of bones. One "undecided point" I should like to discuss with him, namely, the comparative age of these mammalian bones, and of the great quantities of *other* bones usually found here nearer the surface, or on the surface of the red mould with which the caves are filled. Besides the bones of sheep, and swine, and horses, in what Buckland called the churchyard state, there are plenty of fish-bones, and some curious ones too, that puzzle most of my scientific friends, upon a personal inspection.*

Would it be too much to ask you to say where I can "beg, borrow, or get" the notice of the Torquay cave, so as to have an accurate account of the exact position, and state of the flint-chips found there? Some of us—myself for one—live in places so out of the world, that we are practically denied access to sources of trustworthy information near at hand to all metropolitan students.

I want the doctor's opinion, too, as to the date of the breaking up of the usual *older* stalagmitic crust, the thick remains of which adhere to the sides of these caves. I fancy my *fish*-bones were under this in one instance.

I am, Sir, ever yours faithfully,
GILBERT N. SMITH.

Gumfreston Rectory, Tenby, South Wales.
Dec. 19th, 1863.

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* Are any frog-bones? In the Heathery Burn cave there were lots of frogs' bones, which were called fish-bones until the specimens were sent to me for inspection.—ED. GEOL.

Sandstone Hammer in a Diluvial Deposit at Macclesfield.

Dear Sir,—I send a stone-hammer for your inspection, which was found a short time ago near Siddington, about six miles to the west of this town, in a boggy piece of ground, about 2 yards below the surface, and upon the Red Marl. Its length is 7½ inches, breadth 3½, thickness 2½, hole for the handle 1⅜; one end is rounded, the other vertically wedge-shaped; and it is of superior workmanship, having been probably made at the close of the stone-period. In the second volume of the 'Geologist' there are several engravings of sandstone-hammers, but none, I think, similar to the one I have sent you. If you think this of sufficient interest, perhaps you may be induced to give a drawing of it in your next number. In composition it appears to partake in character with some of the lower grits which crop out about two miles distant southward, with a north-westerly dip. All the different beds of grit below the true coal-measures are well developed in this locality, and their basement or Gosedale series are in general very fine-grained, hard, and compact, and produce excellent material for the roads. The Millstone Grit of this district possibly attains a depth of more than 3000 feet. One or two of the upper beds of grit contain thin seams of poor coal, which belong to the lower measures, and are only occasionally worked, not being remunerative; they are not very fossiliferous. It appears rather strange that the natives of this part of the country during the prehistoric or stone age should have resorted to the fabrication of sandstone-hammers, when if the question of durability were at issue, that qualification was always obtainable, since the whole of this neighbourhood was thickly strewed during the glacial period with almost every variety of the hardest igneous rocks, interspersed with hard sandstones and rounded limestones of various geological periods. The advancement of agriculture has now almost obliterated those deposits from the surface of the lower levels and plains, but on higher ground this is by no means the case. The moorlands and elevated districts are still dotted by boulders in every direction, and among some fields about four miles from here eastward, upon an isolated patch of ground some acres in extent and at an elevation of 1000 feet, a remarkable colony of those erratics is still extant. Blocks of quartz-rock, basalts, various granites, greenstones, porphyries, etc.,—more or less grooved, scratched, or smoothed,—lie scattered about in wild and chaotic profusion. There they remain in their primitive position, unaffected by time, untouched by the hand of man, and represent perhaps a true aspect of this part of the country immediately after its last upheaval above the waste of waters. At a mile and a half to the south of the scene just described there is an extensive outlier of the drift, which contains marine shells of arctic type, about 1200 feet above the sea-level. It is chiefly composed of coarse sand and gravel, and in one place has an escarpment of 30 feet. This rests upon a plateau or terrace of shale and grit, which denotes the ancient bed of a swift stream, that has now cut its way almost perpendicularly through the latter strata to a depth of 20 feet. About the middle of the section or escarpment there is a thick bed crowded with large water-worn pebbles and pieces of rough sandstone or grit; and this is also the shell-bed. These have probably been tranquilly deposited by stranded ice, after floating hundreds of miles from their Scandinavian home. The whole of Macclesfield is built upon the drift at an elevation of more than 500 feet. On the eastern side of the town there are two or three distinct terraces or former levels of the river many feet above its present bed, and the superficial sand and gravel overlying the boulder clay contain quantities of minute fragments of boreal shells.

The study of the glacial periods may be considered a most sublime and interesting subject, connected as it is so intimately with the history and antiquity of man. The cataclysms and many other physical phenomena which occurred in these latitudes are amazing; and perhaps it were a misfortune, for the sake of truth and the advancement of science, that the genus Homo existed during the above periods in a low and debased form of organization. For countless ages he trod the earth, in all climes, a wandering savage; and almost the only records left of him as works of art or design, which serve to distinguish him, in point of intelligence, from the brute creation, are a few specimens of rudely-chipped flint-instruments, that were used by him alike for offence, defence, hunting, and other purposes.

From later researches, if the conclusions of the antiquarian and geologist are to be accepted, it would appear that we must remove still further back in geological time the chronology of the human epoch. One species of a low form is mentioned as having become extinct, while it is affirmed that the genus was represented by species in the Pliocene and even the Miocene period. Towards the Eocene beds of Suffolk, this *vexata quæstio* seems to be trending; since in them, according to a certain theory, there is to be found a fossil that may be the earliest prototype of the Bimana.

I am, dear Sir, yours respectfully,

J. D. SAINTER.

Macclesfield, January 5, 1864.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

EAST KENT NATURAL HISTORY SOCIETY.—At an evening meeting, held at Canterbury, on November 24th, a lecture "On the Tertiary Beds of Kent" was delivered by W. Whitaker, B.A., F.G.S., of the Geological Survey of Great Britain, of which the following is an abstract:—

The sedimentary rocks are divided by geologists into three groups, Primary, Secondary, and Tertiary. The formations belonging to the first and oldest of these periods do not occur in the south-east of England, but are confined to the north and west. Of the Secondary period, only the higher formations (the Wealden and Cretaceous rocks) crop out to the surface in Kent. Of the Tertiary beds, on the contrary, only the lower divisions are known for certain to occur in this county, where, however, they are better developed and exposed than anywhere else.

Before treating of the Tertiary formations, it is needful to say a few words of the underlying Chalk, the highest of our Secondary rocks. It is a sea-deposit, rich in fossils, of which many are such as must have lived at a great depth and apparently in the sea of a warm climate. From the fact that the fossils of the overlying beds are altogether of different kinds from those of the Chalk, it has been inferred that those beds were not at once deposited on the Chalk, but that after the deposition of the latter, a long time passed away before other beds were formed over it.

The Kentish Tertiaries belong to the "Eocene," or Lower Tertiary series; and consist, in ascending order, of the Thanet beds, the Woolwich beds, and the basement bed of the London Clay,—grouped together by Prestwich (to whom we owe nearly all our knowledge of these beds) under the name of "Lower London Tertiaries,"—the London Clay and the Lower Bagshot Sand.

1. *The Thanet Beds.*—This formation, almost a purely Kentish one, being but little shown in any other county, thins out a little west of London.

Under London it is from 30 to 40 feet thick, and consists of fine, soft, light-coloured sand, without fossils. It continues the same through West Kent, but with a thickness increasing to 60 feet or more. In East Kent a gradual change sets in, the beds get more clayey, and fossils occur in parts; until the Isle of Thanet, and to the south, there are little else than marls, mostly hard, and clays—with a little sand at top however—often full of fossils, and from 80 to 100 feet thick. At the bottom, *everywhere* there is a bed of clayey greensand, with green-coated flints lying at once on the Chalk.

The number of kinds of fossils in these Thanet beds is small. They are all marine, and seem to be such as would have lived in the sea of a more or less temperate climate; the chief genera are Cyprina, Cytherea, Pholadomya, Cucullæa, Thracia, Nucula, Corbula, Sanguinolaria, all bivalve shells, and Ampullaria. The cliffs and the shore, west of the Reculvers, yield those of the uppermost and more sandy part of the formation; whilst at Pegwell Bay the lower marly part is also shown. At both places there are fossil-bearing sandstones in the upper part. The Bekesbourne cutting of the London, Chatham, and Dover Railway yielded many fossils to Mr. Dowker, one of the members of the Society, who has described this section in a former volume of the 'Geologist.'

Where a section shows a good thickness of the Thanet beds above the Chalk, the junction of the two formations is even; where, however, there is but little of the former, the junction is generally more or less wavy, and there are often large funnel-shaped hollows, known as "pipes." These have been slowly formed by the action of water containing carbonic acid in solution, which has dissolved away the Chalk (carbonate of lime) in an irregular and unequal manner, and the beds above have fallen down into the hollows thus left. It is where the Chalk is but thinly covered, and therefore where water would the more easily filter through to it, that one would expect this action to occur to the greatest extent, and such is the case.

2. *The Woolwich Beds* are remarkable for their ever-changing structure, especially in Kent, in which county, however, there is none of the brightly-coloured mottled plastic clay, that occurs so generally in this formation in the western part of the London basin.

In the "far west" of Kent, near London, the Woolwich beds are about 50 or 60 feet thick, and consist of alternations of sands, beds of pebbles, and clays with shells; and at the bottom, a bed of greenish sand with pebbles, sometimes resting somewhat unevenly on the underlying Thanet Sand.

The shell-beds must have been deposited in a river or estuary, for some of the shells are of a kind that could not have lived in the sea,—such as the bivalve genera Unio, Cyrena, and the univalve Paludina, Neritina, Melania, and Melanopsis. There are also oysters, and other genera that show that the beds are not altogether freshwater, but partly of brackish-water origin. As is usually the case with freshwater beds, fossils are most abundant in numbers, but not in kind,—few species, but hosts of individuals. Mr. Prestwich infers that the river which deposited these shells, and the clay that contains them, flowed down from an island, which he supposed to have occupied at that time part of our present Wealden district. The climate indicated by the shells is that of a temperate region, and the remains of plants that are found here and there, point the same way. These shell-beds are well shown in the large ballast pit, at Charlton, near Woolwich, at Counter Hill (New Cross), Loam Pit Hill (Lewisham), and very many other places.

The great shingle-beds of the neighbourhood of Bromley and Blackheath, have been in part classed by Mr. Prestwich, though doubtfully, with the "basement-bed" of the London Clay; but there is some reason to think that they may all belong rather to the Woolwich beds. In some places, and markedly in the "rock-pit" in Sunderidge Park, near Bromley, and in the railway-cutting at Beckenham, there are fossils in the pebble-beds; and it seems strange that many very delicate shells should be preserved in a loose mass of hard pebbles.

In some places, as on the hill above Abbey Wood, the shell-beds have thinned out, and there is nothing but sand and pebbles from the top to the bottom of the formation. The pebble-beds, as might be expected of deposits of that nature, are merely lenticular masses on a large scale, of great thickness at one spot and near by altogether absent.

Eastward of the valley of the Cray, Tertiary formations have suffered much from denudation, and from Dartford to beyond Gravesend are present only in the form of outliers. The clay shell-beds get thinner, and at the great section on the bank of the Medway, at Upnor, are only 6 feet thick, the sand above, however, also containing shells, but not that below.

For some way east of Rochester this formation has been almost wholly denuded, but it comes on again west of Sittingbourne. Near this latter place the estuarine shell-beds thin out and are not seen further eastward. The pebble-bed at the bottom is also lost, and it is then difficult to draw the line between the Woolwich beds and the underlying Thanet Sand, the former, however, being mostly a coarser and sharper sand, with here and there a few pebbles. The fossils also of the two formations are more alike, those of the Woolwich beds being here of a purely marine kind, and in great part of the same species as those of the lower formation, but of rarer occurrence. The sands that in East Kent represent the Woolwich beds are 25 to 40 feet thick, and are well shown on the coast west of the Reculvers, in sections near Canterbury and Ash, and in the railway-cutting at Richborough Castle.

3. *The Basement Bed of London Clay* consists, near Lewisham and Bromley, of a more or less clayey pebble-bed, from 3 inches to 2 or 3 feet thick, and is well shown in the large pits at Loam Pit Hill, near the former place.

Mr. Prestwich classes with this bed, though somewhat doubtfully, the thick wide-spread mass of shingle of Blackheath, Charlton, etc.; but in the railway-cutting, east of Bickley, a sandy pebble-bed, like that of Blackheath, is seen to be overlaid by the usual clayey pebble-bed at the bottom of the London Clay, and it would seem therefore that the thick mass of pebbles in sand at Blackheath, etc., do not belong to this bed; whether they belong to the underlying Woolwich beds or not, is another question.

From this western part of Kent there are no sections of the "basement-bed" for some distance eastward, and possibly it may have thinned out. At Upnor, near Rochester, however, the whole of the Tertiary beds, from the lower part of the London Clay to the top of the Chalk, are shown. The former is underlaid by some 4 or 5 feet of fine light-coloured sands with shells, in a very friable state, and with pebbles near the bottom. These Mr. Prestwich classes with the "basement-bed," and they certainly seem to be separable from the underlying sands and shell-beds of the Woolwich series, though, on the other hand, they are sharply divided structurally from the stiff London Clay above The fossils in them are, for the most part, of species generally found in the basement-bed (chiefly of the genera Cytherea, Cyprina, Cardium, Pectunculus, Natica, and Lamna teeth); but there are also a few of the estuarine shells of the Woolwich beds, and in abundance Cyrena, Cerithium, and Melania.

This bed (or rather the set of sands, etc., that are usually classed with it) does not occur for some distance to the east, owing to the extent of the denudation of the Tertiaries; coming on again, however, near Sittingbourne with the same general characters and a little thicker. It has been observed in the cutting north of that town, on the Sheerness branch-line. Near Boughton and Canterbury this sand is again shown, and it contains flint-pebbles and ironstone. At the mouth of the tunnel, on the Whitstable Railway, near the second place it may be well seen, and the thick pebble-bed at the base, cemented into a hard mass by the ironstone, is remarkable. At Shottenden Hill there is a great thickness of the flint-pebbles.

The fine cliff-section between the Reculvers and Herne Bay shows this sand-bed very clearly. It has here an average thickness of 20 feet; is crowded with fossils; contains large blocks of hard tabular sandstone, often almost made up of fossils or casts of fossils, and smaller blocks of fossil-bearing iron-sandstone; and has a well-marked pebble-bed, from a few inches to more than a foot thick at the bottom. The fineness and looseness of the sand of this division of the Tertiary series is here well shown: on windy days many tons' weight of this sand are blown away from the face of the cliff, the wind indeed being very powerful in wearing away these cliffs. The fossils are of a London Clay type; but many of them occur also in the beds below. Sharks' teeth and vertebræ are plentiful, and amongst the shells the bivalve genera Cyprina, Cytherea, and Cardium, and the univalves Natica and Aporhais.

In all these East Kent sections, it is to be noted that the London Clay is sharply divided from, and nowhere passes into the sands below, and that it nearly always has a few pebbles, green grains, and sharks' teeth at the bottom, which is rather sandy, and not unlike the undoubted basement-bed in the western part of the London basin, and this may perhaps be the real basement-bed. The underlying sands are more like the beds below them in mineral structure; but more allied to the London Clay by fossils.

4. *The London Clay* is not only of much greater thickness, but also of more uniform mineral character than the lower formations. It consists almost throughout its whole thickness of stiff dark-bluish-grey clay, weathering brown, with now and then a bed of nodular masses of clayey limestone (known as "septaria," from having septa or divisions of carbonate of lime), from which Roman cement is made. The lower part is generally roughly laminated, and abounds in transparent crystals of selenite (sulphate of lime). The upper part, which however rarely occurs, having been for the most part denuded, is also somewhat laminated and sandy, and generally passes up into the overlying Bagshot Sand (present only in the Isle of Sheppey).

The full thickness of the London Clay in the most western part of Kent is calculated to have been about 450 feet; so great a thickness occurs nowhere in West Kent, however, the highest beds of the formation having been denuded. Shooter's Hill, indeed, is the only place where the greater part of the London Clay has been left. In the Isle of Sheppey the thickness is calculated at 480 feet, the greatest known. As might be expected from its greater thickness, the London Clay occurs at the surface over a wider belt of country than the thinner underlying formations.

The fossils, in some places abundant, but often "conspicuous by their absence," show that the clay is a sea-deposit. Moreover, as the many species occur for the most part from top to bottom of the formation, and as the mineral character is the same throughout, it follows that there must have been a slow subsidence going on, to make up for the shallowing of the sea by the continuous deposition of sediment, and thus to allow the life of the age to keep the same during the whole time of deposition of these hundreds of feet of clay, which it could not do if the depth of the sea were so much lessened as would be the case without subsidence.

The only place where any number of fossils have been found in the London Clay in Kent, is the Isle of Sheppey, where, however, the cliffs have yielded a rich harvest both of species and specimens. These, which are from the higher part of the formation, give evidence of the existence in those long-past ages of corals, star-fishes, sea-urchins, an abundance of Crustacea (crabs, lobsters), often forming the nucleus of septaria, mollusks in great plenty, fish (especially sharks, the teeth of which are very common), and rays and reptiles (turtles, tortoises, crocodile, and serpent.) The remains of a small pachydermatous mammal have been found near Herne Bay. The most remarkable of the Sheppey fossils, and which are far less common elsewhere, are the plant-remains. These are chiefly of the leguminous and coniferous orders and palms, and consist of fruits, seeds, and stems. They are in iron-pyrites (sulphide of iron), and therefore very difficult to keep, as that substance often decomposes when exposed. They show that the neighbouring land on which they grew must have been much warmer than our present temperate climate; and this evidence is strengthened by that of the remains of the Mollusca, amongst which the univalve Nautili, Cones, Cowries, and Volutes show that the sea in which they lived must have been in a warm climate. Shells of many other genera occur, such as Fusus, Natica, Pleurotoma, Rostellaria, and the bivalves Cardium, Pectunculus, and Teredo, a great deal of the wood having been bored by the last. These shells, like the vegetable remains, are in the state of casts in iron-pyrites.

The middle and lower beds of the London Clay, near Whitstable and Herne Bay, have yielded fewer fossils.

A noteworthy feature of the London Clay cliffs is the frequent occurrence of landslips; nearly the whole face of the sloping cliff being generally made up of the fallen masses. In dry summer-time the clay is shrunk by the heat, and deep cracks are formed; when rain falls, much water finds its way down these cracks, loosens the clay, and makes it slippery, so that masses can more readily fall down. The destructive action of the weather is, however, greatest in the winter, when the water in the deep cracks freezes, and the vast force put forth in its expansion, on becoming ice, loosens the beds, which would then tend to slip down after a thaw. Early in the present year (1863) a slip occurred which threw a long strip of land, about two acres in extent, some way down the cliff: the young wheat was growing very well in its strange position.

5. *The Lower Bagshot Sand* occurs in the form of a thin outlier on the highest part of the Isle of Sheppey; the only place in Kent where the London Clay is capped by this formation, which has been worn off altogether in other parts of the county. The sand is light-coloured, more clayey towards the bottom, and generally passes into the sandy clay forming the uppermost part of the London Clay. It may be seen for more than a mile along the cliff near Minster, and is at the most some 30 feet thick.

Although of so small extent and thickness, this outlying mass of sand is of much geological value. Firstly, it proves that the Bagshot series once spread over these parts, as the outliers at Rayleigh and elsewhere on the opposite side of the Thames prove its former extension over Essex; and, secondly, it enables us to calculate the thickness of the London Clay from top to bottom, which clearly could not be done without that formation being capped somewhere by a mass of the next overlying one, to show the real top; its bottom being shown by the outcrop of, or by wells being sunk through to, the formation next below.

6. *Crag* (of Prestwich).—Near the edge of the Chalk escarpment near Folkestone, and to a smaller extent in other like places, there is found a deposit of sand, often ferruginous, the age of which is not yet made out with certainty. It seems not to be connected with any of the older Tertiary beds, and it is not like any of the Drift-beds of the district. From the occurrence of a peculiar set of fossils in a pipe of this sand in the Chalk above Lenham, Mr. Prestwich was led to class it with the "Crag," an Upper Tertiary formation of much later date than any we have been considering. The fossils, however, being only in the state of casts in ironstone, and merely from a small pipe, the evidence is hardly conclusive, and the classification must be looked on as provisional. There is therefore a very doubtful point in the Tertiary Geology of their county for the "East Kent Naturalists" to work out.

Geological Society.—*December* 2, 1863.—1. "On the Correlation of the Oligocene Deposits of Belgium, Northern Germany, and the South of England." By Herr Adolf von Koenen. Communicated by F. E. Edwards, Esq., F.G.S. Railway-cuttings in the New Forest (Brockenhurst, etc.) have recently exposed certain marine beds overlying the Lower Headon (freshwater) series, and containing fossils hitherto unknown in England, but which, as Herr von Koenen showed, constitute the marine equivalent of the Middle Headon strata.

The author gave an exposition of the current opinions upon the correlation of those English and foreign "Upper Eocene" or "Lower Miocene" strata, to which Professor Beyrich has given the name "Oligocene," and briefly sketched their distribution and limits upon the Continent. He then gave a list of fifty-nine New-Forest (Middle Headon) fossils, which he had determined, and stated that, of this number, forty-six occur in the Lower Oligocene of Germany, and twenty-three are characteristic of that formation; twenty-one of these species occur in the Barton Clay, four in the Middle Oligocene, and eight are peculiar to the Brockenhurst beds. He therefore concluded that the Headon and Brockenhurst strata are on the same horizon as the Lower Oligocene; and he confirmed the opinion of previous observers, that the Hempstead beds are the equivalent of the "Grès de Fontainebleau" and of the Middle Oligocene of Germany.

2. "On the Liassic Strata of the Neighbourhood of Belfast." By Ralph Tate, Esq., F.G.S.

In the neighbourhood of Belfast the following members of the Lias formation were stated to occur, namely:—The zone of *Ammonites Bucklandi*, the White Lias, and the zone of *Avicula contorta*.

The characters of these subdivisions in the district under consideration were described in detail by Mr. Tate, who gave sections of the beds exposed in Colin Glen and at Cave Hill, at which localities the three zones are seen; he also gave sections of the *Avicula contorta* beds as exposed at Woodbarn and at Whitehead, and lists of the fossils found in the strata of each subdivision at the localities mentioned, noticing that, in the zone of *Ammonites Bucklandi*, that Ammonite is replaced by *A. intermedius*, the other fossils being of the same species as occur in that zone in England; and he concluded with some general remarks on the distribution of the members of the Lias in the North of Ireland.

3. "Notes on the Devonian Rocks of the Bosphorus." By W. R.

Swan, Esq. In a letter to Sir R. I. Murchison, K.C.B., F.R.S., F.G.S., etc.

The lithological and stratigraphical characters of the rocks of the Bosphorus having been noticed, the author gave a general description of the fossils occurring in them,—namely, *Spirifer* (broad-winged and small species), *Orthis*, and other Brachiopods; *Homalonotus* and other Trilobites; together with Corals of the genus *Favosites* associated with the well-known *Pleurodictyum problematicum*. Graptolites were stated to be entirely wanting, and Cephalopods to be very rare. Mr. Swan therefore inferred that these strata were of the age of the Lower Devonian rocks of the Rhine.

December 16, 1863.—1. "On the Pebble-bed of Budleigh Salterton." By W. Vicary, F.G.S. With notes on the Fossils by J. W. Salter, F.G.S.—The south coast of Devonshire, from Petit Tor, near Babbacombe Bay, to a little beyond Sidmouth, exhibits cliffs of New Red Sandstone; one of the beds of which, near Budleigh Salterton, is composed of pebbles of all sizes and of a flattened oval form: this bed attains a maximum thickness of about 100 feet, and some of the pebbles composing it were found by Mr. Vicary to contain peculiar fossils.

Mr. Vicary gave a description of the physical features of the area over which the pebble-bed extends, and entered into the stratigraphical details of this and the associated strata, referring to Mr. Salter's note for information upon the affinities of the fossils. In his note, Mr. Salter observed that, on comparing the fossils of the Budleigh Salterton pebbles with those from the Caen sandstone in the Society's Museum, he found that all the species contained in the latter collection were also represented in the former. The general aspect of the fossils was stated to be quite unlike that exhibited by English Lower Silurian collections, and Mr. Salter therefore suggested that the exact equivalent of the Caen sandstone does not exist in England. This difference in the two faunas appeared to him to favour the theory of the former existence of a barrier between the middle and northern European regions during the Silurian period.

2. "Experimental Researches on the Granites of Ireland.—Part IV. On the Granites and Syenites of Donegal, with some remarks on those of Scotland and Sweden." By the Rev. Samuel Haughton, F.R.S.—The author discussed in detail the mineralogical composition of each of the fifteen Donegal granites, and described the method usually employed by him in solving lithologico-chemical problems, coming to the conclusion that nearly half of these granites are not composed altogether of the four minerals (quartz, orthoclase, oligoclase, and black mica) which are found in them in distinct crystals, and that the remaining varieties, even if they be composed of these minerals, must have a paste composed of the same minerals, but with a slightly different composition. Professor Haughton then discussed the composition of the syenites of Donegal, and instituted a comparison between the granites of that district and those of Scotland and Sweden, remarking that those of the last-named region have the same stratified structure as the granites of Donegal.

3. "On the recent Earthquake at Manilla." By J. W. Farren, Esq. Communicated by the Foreign Office.—In two letters to Earl Russell, the author described the damage done by this earthquake, observing that 289 persons were killed, and a large number more or less injured.

4. "Extracts from Letters relating to the Further Discovery of Fossil Teeth and Bones of Reptiles in Central India." By the late Rev. S. Hislop. Communicated by Professor T. Rupert Jones, F.G.S.—The remains alluded to consist of (1) a series of reptilian bones, some bearing

teeth, mostly Labyrinthodont, and some probably Dicynodont, from the (Triassic?) red clay of Maledi, in which teeth of Ceratodus occur; and (2) several teeth similar to one from the Eocene clays of Takli, near Nagpore, and another like a conical tooth from the Eocene beds (with *Physa Prinsepii*) of Physura, from the same neighbourhood as that in which the set No. 1 was found. At Phísdura (Tertiary) large reptilian bones (including a femur 1 foot across at the condyles, and a vertebral centrum seven inches across) have been found associated with large coprolites, *Physa Prinsepii*, and *Paludina Deccanensis*. Mr. Hislop stated his belief that the Mangali beds, the Kordihad shales, and the red-clay of Maledi, should be placed above the plant-bearing beds of Nagpore, instead of below them, as heretofore supposed.

January 6, 1864.—1. "On the recent Geological Changes in Somerset, and their date relatively to the Existence of Man, and of certain of the Extinct Mammalia." By G. S. Poole, Esq.

In describing the general physical features of the district treated of, which lies between Clevedon and Taunton, the author noticed especially the embankments which protect the land from periodical inundations, stating his belief that they were constructed by the Romans; he also described the "turbaries" or peat-moors, endeavouring to explain their mode of formation, and noticing their relation to the alluvium and the sand-banks of the district. Mr. Poole then endeavoured to prove that the area under consideration had been subject to considerable changes of level in comparatively recent geological times, and that man existed in the district prior, and some of the extinct mammalia subsequently, to the last of such changes,—asserting, in support of the last conclusion, that the remains of *Elephas primigenius, Rhinoceros tichorinus*, etc., had been found in a stratum above that containing the bones of man and pieces of pottery; and he concluded by examining the evidence of the extent and date of the last subsidence.

2. "On the Structure of the Red Crag in Suffolk and Essex." By Searles V. Wood, jun., Esq. Communicated by Searles V. Wood, Esq., F.G.S.

By reference to a tabulated description of about fifty sections taken from various parts of the Red Crag area, the author showed that the deposit is structurally divisible into five stages, of which the 1st, 2nd, 3rd, and 4th (counting upwards) were not deposited under water; but from their being regularly laminated, at angles varying between 25° and 35°, and possessing (with the exception of the 2nd) an unvarying direction in every stage, he regards them as the result of a process of "beaching up," by which was formed a reef extending from the river Alde on the north, to the southern extremity of the deposit in Essex. Of these four stages, the 4th is the most constant and important, the 1st, 2nd, and 3rd being frequently either concealed by, or destroyed during the formation of the succeding stages. At Walton-on-Naze alone do any of the four lower stages contain evidence of being a subaqueous deposit; there the 1st stage is so, but it is covered by two reef stages, and these again by the 5th stage.

The 5th stage is invariably horizontal, and contains evidence of having been formed under water. This stage is developed in such a way as to show that it was formed in channels eroded in the older reef, and it is at its base that the coprolite workings occur. This stage also passes up at Chillesford into the sands and gravels, termed by the author the Lower Drift, which underlie the boulder clay; at other places a line of erosion exists between the 5th stage and the drift-sands.

Jan. 20.—1. "Observations on supposed Glacial Drift in the Labrador Peninsula, Western Canada, and on the South Branch of the Saskatchewan." By Professor H. Y. Hind, Toronto.

During an exploration of a part of the interior of the Labrador peninsula, in 1861, the author had an opportunity of observing the magnitude, distribution, and extraordinary number of the boulders on the flanks of the table-land of that area; and he commenced this paper with a detailed account of the results of his observations, referring also to the forced arrangement of blocks of limestone, shale, and Laurentian rocks in Boulder-clay at Toronto, and on the south branch of the Saskatchewan.

Professor Hind then described briefly the Driftless Area, in Wisconsin, discovered by Prof. J. D. Whitney, and the conclusions to which that geologist has been led by the study of this district. He next adverted to the beaches and terraces about the great Lakes, and considered their origin to be similar to that suggested by Mr. Jamieson for the Parallel Roads of Glen Roy. The formation of anchor-ice in the Gulf of St. Lawrence and at the heads of rapids in the great river itself was alluded to as one of the means by which river-beds may be excavated. The parallelism of escarpments in America, at great distances apart, and at elevations varying from 600 feet to 3000 feet above the sea, was next described, and their symmetrical arrangement suggested to be the result of glacial rivers undermining the soft strata of sedimentary rocks in advance of the glacial mass itself. These escarpments were also thought to represent different and closely-succeeding glacial epochs.

2. "Notes on the Drift-deposits of the Valley of the Severn, in the neighbourhood of Coalbrookdale and Bridgenorth." By George Maw, F.S.A., F.L.S.

The patches of Drift occurring in the Valley of the Severn from about four miles below Bridgenorth up to Shrewsbury, including a north and south range of about twenty miles, have been carefully examined by the author, and were described in detail in this paper.

Commencing with Strethill, a hill close to the entrance of Coalbrookdale, the author described the several beds which make up the Drift-deposits of which it is composed, and gave a list of the rocks which he had found in them. In the same manner he described in succession the neighbouring districts in which the Drift-deposits are exhibited, and gave a list of the fossils which had been found in the beds at the different localities.

In conclusion Mr. Maw put forward some hypotheses as to the period when the degradation of the older formations (the materials of which compose the Drift) took place, the manner in which the Drift was deposited, the extent of the submergence of England and Wales during the period of its deposition, and the influence of glaciers and glacier-action in its production.

ROYAL SCHOOL OF MINES.—TWELVE LECTURES ON CHEMICAL GEOLOGY, BY DR. PERCY, F.R.S. — *December* 10*th*, 1863. — Geology has for its object the study of the nature and mode of formation of the exterior of the earth, which alone is accessible for investigation. That exterior is usually designated the "crust" of the earth, an expression which implies necessarily that the interior is not solid, but is in a state of greater or less liquidity. The received hypothesis is, that our planet was once molten, and that in the lapse of ages it has gradually cooled down, and has become solid on its surface. The lecturer did not propose to examine the foundations of this hypothesis; but used the word "crust" simply because it is a term perfectly well understood, and generally accepted, and not as any exponent of the lecturer's belief.

We are acquainted altogether with about sixty elementary bodies; and it is really remarkable how few constitute the great bulk of the earth's crust

—not more than five. These are—silicon, aluminium, calcium, oxygen, and carbon. The states of combination in which they occur are—silica, that is, silicon combined with oxygen; alumina, or aluminium with oxygen; and lime, or calcium with oxygen; and this lime is, for the most part, or, at all events, to a very large extent, in combination with carbonic acid, constituting marble and limestone in its various forms. Perhaps next in abundance we may rank magnesium; then, perhaps, would come hydrogen, iron, sodium, potassium, manganese, chlorine, sulphur, and phosphorus. The hydrogen is that existing in combination with oxygen in the form of water, and present in a state of solid combination in all clay. It is not there, as chemists term it, as hygroscopic water, water simply of moisture, which can be expelled at a low temperature, but it is there in a state of actual solid combination, and may therefore be considered as one of the constituents.

The geologist everywhere meets with problems of the highest interest which chemistry alone can solve; yet it is somewhat surprising that in this country the application of chemistry to the solution of geological phenomena should hitherto have received so small a share of attention. Not a few persons have attained the reputation of geologists who have either been ignorant of the great foundations of the philosophy of geology, or have had a very slight knowledge of the subject. To know and to remember the order of superposition of rocks, and to be able to recognize the fossils which they respectively contain, does not entitle a man to rank as a philosophical geologist. As well might a taxidermist lay claim to the title of zoologist, or an ornithologist to the title of botanist. The conquests which remain to be achieved in geology will, doubtless, result from the special study and application of the various sciences, and there is assuredly no line of investigation which promises richer fruit than chemistry.

The subject of this first lecture is silicon, perhaps the most abundant, or, certainly, one of the most abundant elements in the solid crust of the earth. This silicon has only recently been investigated in anything like a satisfactory manner. It exists in, and is the foundation of silica in its various forms. Silica exists in the well-known form of quartz, and consists of silicon combined with oxygen. In sand and in all clay, and in igneous rocks of various kinds, it is an essential constituent. In fact, it is everywhere. This silicon, when once united with oxygen, requires an extraordinary amount of affinity, or the exercise of an extraordinary force to *detach* it therefrom. It exists in three distinct states, the amorphous or formless state, in the graphitic state, and in the state of crystallized octahedral silicon.

In its three states, silicon differs considerably. In the amorphous state it occurs in the form of a chocolate-brown powder. In the graphitoidal state it is exactly like graphite, or very similar, occurring frequently in small hexagonal plates, as produced in the process for making aluminium. Then we have the octahedral form, the same form and the same crystalline system as that to which the diamond belongs. But here it is a most beautiful substance, of a metallic lustre, and a dark bluish-grey colour, considerably more blue than ordinary graphite, and more metallic in lustre. Silica consists, in round numbers, of about 48 parts of silicon and 52 of oxygen. The atomic formula adopted, and first suggested by Berzelius, is $Si\,O_3$, representing one equivalent of silicon combined with three of oxygen; but there are reasons for supposing that the more accurate expression is $Si\,O_2$, one equivalent of silicon combined with two of oxygen. Long ago it was ascertained by Schafgotsch that silica exists in two very different states. In one state crystallized as quartz, having a specific gravity of

2·6. All quartz, for example, has this specific gravity, and not only quartz, but chalcedony, hornstone, and flint, and yet these present no outward sign of crystalline structure. It is, however, maintained by Rose, and with some plausibility, that they consist of an aggregation of excessively minute crystals. He designates these forms of quartz as *crystalline*, in contradistinction to the ordinary form of rock crystal, which is distinctly *crystallized*. We have, then, crystalline quartz, and this apparently non-crystallized form of quartz just mentioned, chalcedony and the like, of the high specific gravity 2·6.

There is another form of silica in which the specific gravity never exceeds 2·3. It ranges from 2·2 to 2·3, and is never higher than that. This is what is termed amorphous, apparently non-crystalline silica; and these facts have, or may have, a very important bearing on certain geological considerations. All the crystallized silica of the high specific gravity polarizes light. The amorphous silica of low specific gravity does not polarize light. The distinctly crystallized silica which we have in quartz, when pulverized, reduced to extremely fine powder by trituration and levigation, does not differ chemically in any sensible respect from the powder of the apparently amorphous form of silica, flint, chalcedony, and the like. Both resist the action of boiling alkaline solutions, whereas the amorphous silica is copiously and readily dissolved by such solutions. The crystallized silica is produced in the wet way, and, so far as we know, only in the wet way. By the wet way is meant through the agency of liquids, never by fusion at a high temperature. The late M. Senarmont, who devoted considerable attention to the artificial formation of minerals, made microscopic crystals of quartz by dissolving silica in the nascent state in very dilute hydrochloric acid, and then exposing that solution in a closed tube to a temperature of between 200 and 300 centigrade; exactly similar, in all essential respects, to the rock-crystal of nature. It is true that the crystals were very small; but that in no way affects the truth of the conclusion. Sorby obtained crystalline silica by passing chloride of silicon into a tube along with the vapour of water, but he afterwards procured still more distinct crystals by decomposing glass at a high temperature by the agency of water. We may take an ordinary piece of glass and boil water in it for almost any length of time, without appreciably acting upon it; but if we expose ordinary glass to the action of water at a high temperature in a close vessel, the result is different, and the glass is rapidly attacked and corroded. By acting upon glass consisting of silica, lime, and potash, by water, at a high temperature, he obtained the well-known mineral Wollastonite, which is a silicate of lime; and he obtained perfectly transparent crystals of quartz, not less than two millimetres in length,—a distinct experimental proof of the formation of characteristic crystals of quartz, similar to those occurring in nature, by the agency of water. It is a fact that the heavy compact and the crystallized silica often occur together, and hence we may infer the similarity of the conditions of their formation.

To avoid confusion about crystalline and amorphous silica, it must be borne in mind that there is quartz which is distinctly, manifestly crystallized with the specific gravity of 2·6. Then we have silica of the same specific gravity, yet not appearing crystalline to the eye, although there are certain reasons for supposing that it may be composed of an aggregation of excessively minute crystals. Then there is the other distinctly amorphous non-crystalline variety, which has the low specific gravity of 2·3. Thus there are two apparently amorphous varieties of silica,—chalcedony, for example, and opal. If we compare common quartz with opal, both appear non-crystalline, and both, therefore, might be confounded under the term "amorphous;" but the term "amorphous" is restricted to this particular form of solid silica having the low specific gravity.

All attempts to crystallize silica by fusion have hitherto failed. Many experiments were made upon this subject a long time ago by means of the oxy-hydrogen blowpipe. Silica has been distinctly fused into small globules; there is no great difficulty about that. More recently, Deville, who has paid special attention to the application of high temperatures to metallurgical purposes, has succeeded in fusing silica in considerable quantities, and he has subjected it to slow cooling, but never in a single instance has there been the slightest trace of crystallization; and such silica—silica fused at these high temperatures—has always the low specific gravity of 2·3. The bearing of this will be seen by-and-by upon the supposed formation of granite and certain other igneous rocks. If we take a piece of crystallized quartz of a high specific gravity, and fuse it, we convert it into a substance somewhat resembling the silica of the low specific gravity, having the gravity of 2·3. Now that is apparently a small fact, but in a geological point of view it is one of the highest interest. Formerly, it was a marvel to melt a bit of platinum as big as a pin's head; now, Deville has succeeded in melting it in mass. This platinum sometimes contains silicon, and in fusion the silicon becomes oxidized, and converted into silica,—the melted silica swimming on the top of the melted platinum in the form of a thin, transparent, colourless liquid.

Gustave Rose found, that when perfectly transparent, entire rock-crystal underwent long exposure, say for eighteen hours, to a porcelain furnace, in which the temperature is exceedingly high,—being estimated at about 2000° centigrade—there was no alteration in the specific gravity at this temperature; but when the same crystal was exposed to the same conditions of temperature, having been previously pulverized—reduced to fine powder—its specific gravity was reduced from 2·6 to 2·3. Again, he found in the case of common flint having a specific gravity of 2·591, owing to certain impurities which interposed, that by exposure to this high temperature for a long time, its specific gravity was reduced to 2·237; another example of the influence of high temperature in reducing the specific gravity of silica in this particular state of aggregation.

We have now to consider more particularly this amorphous silica, or that form of silica to which Professor Graham has so well given the name of "colloidal, or jelly-like silica." This silica is obtained in various ways; one is by the decomposition of silicates by acids. Silicate of potash or silicate of soda will dissolve readily in water, the solution being known as water-glass; if we add, under certain conditions, an acid to that water-glass, the silica will immediately separate in the form of jelly. Under other conditions of dilution there would be no immediate separation of jelly whatever, but the whole of the silica will be retained in solution, though it be separated from its combination with the base by the addition of a stronger acid; but, on keeping, it will ultimately gelatinize, or during evaporation, by the application of heat, the silica will be thrown down in the jelly-like state. When evaporated to dryness, this jelly forms a white, amorphous powder. This gelatinized silica, or colloidal state of silica, is produced by the action of water on a peculiar compound termed "fluoride of silicon,"—a gaseous compound, consisting of silicon in combination with the element fluorine, which is an essential constituent of common fluor spar. It is a perfectly transparent, colourless gas, which immediately suffers decomposition by contact with water; hence, when this gas is allowed to escape into the atmosphere, under ordinary circumstances it produces a copious white smoke, due to the formation and deposition of silica. If fluor spar and sand be mixed with sulphuric acid, fluoride of silicon is formed, which, in passing through water, becomes immediately decomposed, depositing gelatinized silica. If we plunge the delivery-tube, conveying the gas, into water, the quantity of silica immediately produced would be so great as to stop up the tube, and to burst the flask. In order to avoid that effect, it is usual to place at the bottom of the vessel a quantity of mercury, over which is the water, and to let the gas escape in the mercury, and below the water. This gelatinous silica, when dry, forms an exceedingly light powder. In fact, it is in a state of the extremest possible division. As far as I know, there is no other way of making amorphous silica in such a fine state of division as this.

The solubility of silica is a subject of very high importance to geologists. In an aqueous solution of potash, for two parts by weight of solid potash in solution there is dissolved one part by weight of this extremely fine silica in fluoride of silicon. Of silicon in the state of quartz there is dissolved ·009 for two parts by weight, and of silica in the state of flint there is dissolved ·038. This difference is due simply, or at all events in a great measure, to a difference of aggregation. When rock-crystal has been actually melted, and then pulverized, it is as soluble in this menstruum as the silica from the fluoride of silicon. Silica dissolves, to a certain extent, in water containing alkaline carbonates. The light variety is far more soluble than the heavy variety. An aqueous solution of carbonate of potash, or soda, for example, dissolves fifteen times more amorphous than crystalline silica. With regard to the solubility of silica in pure water, Bischoff states, that one part of silica dissolves in 769,230 parts of water.

Some results obtained by Professor Graham are as interesting as they are novel and important,—the phenomena of dialysis, which will possibly hereafter be found to explain many obscure geological phenomena.

Some paper, termed "parchment paper," is tied round a hoop of gutta-percha, forming a circular vessel, the bottom of which consists of parchment paper. Into a glass vessel place pure water, and into the hoop place a solution of silicate of soda to which acid has been added in such a way as not to precipitate the silica, then place it on the pure water, and leave it. What will take place? In the course of time a certain proportion of the silica will pass through that membrane into the other constituents in the solution, but eventually there will remain in the floating hoop, covered with the parchment paper, a pure solution of silica. All the hydrochloric acid will be gone by virtue of the operation of that paper. The chloride of sodium or potassium, as the case may be, will be gone,—with a certain proportion of silica, it is true,—and there will remain at length a pure, limpid, colourless solution of silica.

Amongst the illustrations supplied by Professor Graham for this lecture, was a 5 per cent. solution of silica. There was no base to retain that silica in solution. It was a pure limpid solution of silica in pure water. In the course of time, if the solution has a certain strength, it will gelatinize, or, as Professor Graham calls it, pectize—form jelly. The weaker and purer the solution, the less tendency it has to gelatinize. Professor Graham expresses an opinion, that with 1 per cent. of silica the solution might be preserved for an indefinite length of time without change.

There are some very curious properties about this solution to which the lecturer is very anxious to call the attention of geologists. This solution may contain as much as 14 per cent. of silica, and yet be perfectly limpid, and not in the least viscous. It may be boiled in a flask for a considerable time, and concentrated considerably without change. When heated in an open vessel, a ring of insoluble silica is apt to form around the margin of the liquid, and this may soon cause the whole to gelatinize. The solution is, as I said, durable in proportion to its purity. It is not easily preserved beyond a few days, unless considerably diluted. It becomes opalescent after a short time, and then the jelly separates; and once separated it cannot be redissolved in water. When the jelly is formed suddenly it is always more or less opalescent. Formed slowly, it is a jelly, perfectly colourless and limpid, like rock-crystal. If touched slightly it gives rise to a vibratory tremor. It contracts, after a few days, even in a close vessel, and then pure water separates from it. It is a very curious fact that coagulation, or the separation of silica in the jelly-like state, is effected in the course of a few minutes by a solution containing one ten-thousandth part of any alkaline or earthy carbonate, but not by caustic ammonia or neutral or acid salts, nor by sulphuric, nitric, or acetic acid. Coagulation occurs in a short time after passing carbonic acid through the solution. A little carbonate of soda to it will make it so solid that it may be inverted without spilling. When it is suddenly made so, it is always opalescent, and not transparent. Dried by the air-pump *in vacuo*, at the ordinary temperature, it forms a beautiful, transparent, glassy mass of great lustre, no longer soluble in water, and which reminds one greatly of that beautiful variety of opal termed "hyalite."

Ordinary silicate of soda is not at all what is termed "colloidal;" if silicate of soda were put into the hoop-vessel, and left there floating upon the water, it would pass through, to a certain extent, to the water, but there would be no separation of its constituents. When hydrochloric acid is added and the constituents eliminated, then this action is set up. This soluble form of silica unites with various organic matters, as, for example, with common gelatine, or with skin. In fact you may tan by means of silica, and produce leather containing as much as 70 per cent. of silica.

We will now inquire whether there is any reason to suppose that a similar process may play any part in the operations of nature. The condition required is a soluble silicate dissolved in water, and the decomposition of that silicate by some agent, such as hydrochloric acid. Does nature present us with any apparatus which can take the place of this so-called dialyser? All that we want is the porous bed of some rock like sandstone, in some convenient position, and that sandstone will act exactly as the dialysing apparatus.

In the separation of the silica every bubble of the fluoride of silicon as it passes up through the water becomes immediately decomposed, and a portion of the gas escapes, not being thoroughly in contact with the water everywhere, and produces a slight smoke. We have reason to believe that this solution may play an important part in the phenomena of nature; for there is no difficulty in explaining how such a solution may be obtained as is requisite to exhibit the phenomena of dialysis; and very probably in nature we may find conditions exactly suitable for dialysis. If this be the case, we shall be at no loss to understand how in many instances silicification has occurred. We know that it has occurred, and to an enormous extent, in nature. The mineral termed "opal" is nothing more than amorphous silica containing a little water. The proportion of water is not definite; it is variable, the extremes being somewhere about 3 per cent. and 13 per cent of water. Sometimes this opal exhibits most beautiful colours, and then it acquires the name of "precious opal."

These colours are due to a peculiar structural arrangement, and may be explained by the laws of optics. And if any one will examine the opal from Mexico and the substance prepared by evaporation *in vacuo* by Professor Graham's experiment, he cannot fail to be struck with the resemblance between the two. The mineral termed "hyalite" is also a kind of opal met with in basaltic rocks. It is another form of amorphous silica. This hyalite contains an amount of water, the extremes of which are 3 and 6 per cent.

The processes carried on in our blast furnaces or iron-smelting furnaces on so large a scale in various parts of this country, may really furnish indications of great importance to the geologist. In the hearths of blast furnaces is occasionally found a white, delicate, fibrous substance, to which the name of "fibrous silica" has been given. It has been carefully examined, especially by Rose, who finds it to consist essentially of silica. It is silica in the amorphous state, produced at a high temperature, and, therefore, having a specific gravity not exceeding 2·2 or 2·3. We are not perfectly certain yet as to the precise conditions under which it has been generated, but most likely it may have resulted from the oxidation of silicon. Sorby informs us that he obtained fibrous silica, exactly similar to that occurring in the hearts of blast furnaces, by passing fluoride of silicon, together with the vapour of water, through a porcelain tube heated to red-whiteness. By introducing the fluoride of silicon at one end of the tube, and the steam at the other, he obtained silica only in small vitreous grains. That is the amorphous silica.

In concluding this lecture, the lecturer said he could not help forestalling what he should say hereafter as to the formation of certain igneous rocks, especially of granite. For a long time it has been the received notion, that all granite, which occurs so abundantly in the crust of the earth, has been the result of igneous fusion at a very high temperature; but there are certain difficulties which have always been in the way of accepting this view of the subject,—difficulties known, at all events, to those who have been accustomed to make experiments on the fusion of mineral substances at high temperatures. Now, let us look at the fact of quartz occurring in this granite. Granite consists, as most of us know, of three minerals—quartz, mica, and felspar; and the quartz in it is crystallized, and always has the specific gravity 2·6. There is not a single instance known to the contrary. There is therefore reason to believe that that quartz never could have been fused; for we have seen that the moment we fuse silica, no matter in what state it was previously, we obtain a glass-like colloidal or non-crystalline mass, having a specific gravity never exceeding 2·3. In this fact he thought it would be agreed that there is something like a foundation for the inference (even from this single fact) *that such granite could never have been produced under the condition of a high temperature.* What those conditions were under which it was produced would be hereafter considered.

MANCHESTER GEOLOGICAL SOCIETY.—24*th November*, 1863.—A new safety-hook was described by Mr. George Wild, and the results of an attempt to get information from coal-proprietors twenty-four years ago, was brought before the meeting by Mr. Binney. It appears that to 250 circulars by the Society, only one reply was received,—from Mr. Ralph Thicknesse, of Wigan.

COLONIAL GEOLOGY.

AGE OF NEW SOUTH WALES COAL-BEDS.

By Mr. Daintree.

The 'Yeoman, and Australian Acclimatizer,' publishes an article on the "Age of the New South Wales Coal-beds," by Mr. Daintree, one of the gentlemen connected with the Geological Survey Department of this colony, from notes collected "during a three months trip from Melbourne to the Upper Burdekin, Queensland." One of the most important facts mentioned in these notes refers to the dispute which has been long pending between the Rev. Mr. Clarke, of New South Wales, and Professor M'Coy, as to the age of the New South Wales coal-fields. It must be satisfactory to Mr. Clarke to find that a gentleman of Mr. Daintree's experience and undoubted qualifications has done something towards turning the dispute in his favour.

The history of this dispute, says our contemporary, deserves attention. The Rev. W. B. Clarke, of New South Wales, has long been distinguished as one of the best practical geologists in this hemisphere. In numerous instances he pointed out where gold deposits would be found long prior to their actual discovery. He had also examined and reported upon the coal-strata of the sister-colony, and from a careful observation of the strata in position, and by the character of the fossil remains, he had arrived at the conclusion that some of the coal-beds of New South Wales are of the same age as the Lower Carboniferous series of Europe. Professor M'Coy, however, before he left England, had adopted a notion that the New South Wales coal is Oolitic, but that the marine fossils in the same neighbourhood, often found in contact with the coal-beds, are Lower Carboniferous. With a pertinacity almost amounting to stubbornness, Professor M'Coy has adhered to the notion he had formed. After the Professor removed to the southern hemisphere, he did not think it worth while to visit the coal-beds in dispute, but continued to controvert, often with unseemly and even reprehensible bitterness, the opinions of Mr. Clarke, who took an early opportunity of asking European geologists to suspend their judgment in the matter for a time, as he felt perfectly convinced of victory in the end. Mr. Clarke's argument was, that the coal could not be Oolitic and the marine fossils Lower Carboniferous, for in one locality examined—namely, Russell's pits, Stony Creek, Maitland (and at other places)—the coal-seams, with the plants in dispute, lie a long way *below the marine beds.* Some years ago Mr. Clarke sent a section of the coal-strata to the Royal Society of Victoria. Professor M'Coy and Mr. Selwyn rejected it, on the pretence that there was a "fault" in the strata; and in the opening address of the president of the society (Sir Henry Barkly) in 1861, judgment was given against the opinions of Mr. Clarke. Throughout the dispute, that gentleman has been often unfairly dealt with, and harder things have been said than have appeared in print. In vol. v. p. 107, of the Transactions of the Royal Society of Victoria, there is a passage in a paper by Professor M'Coy, pretending that Mr. Clarke told him and Mr. Selwyn that the specimen produced by Mr. Clarke in proof of his opinion was one of plants belonging to beds from which it had fallen, or might have fallen, from the top to the bottom of the shaft. Mr. Clarke replied to this statement, but it was afterwards repeated (*vide* p. 217, vol. v. of the Royal Society's Transactions), as if Mr. Clarke, who produced the specimen in proof of the age of the coal, could have admitted that all he had said was untrue. The 'Australian Yeoman' is convinced that Mr. Clarke is right, and congratulates him on his triumph over a stubborn foe.

Then follow the geological notes collected during a three months' leave of absence, spent in a trip from Melbourne to the Upper Burdekin, Queensland (with a plan and section), by Richard Daintree, field geologist, Victoria; the substance of which is,—

Starting from Melbourne, the Tertiaries of Port Philip Heads, the Amygdaloids of Cape Schank and Philip Island, succeeded by the cliffs of the Cape Paterson Carbonaceous strata, were rapidly passed. Next, the granite of Wilson's Promontory and the low sandy Tertiaries of Gipps Land. The promontory of Cape Howe was scanned, in the hope that it would afford some connecting link between the eastern extension of the Carbonaceous strata of Gipps Land and the southern coal-fields of New South Wales, but, from the distance no sign of stratified rocks could be discovered.

Kiama was the first point where sedimentary strata, traversed apparently by dykes of so-called "older basalts," met the view; they form part of the New South Wales coal-group. Here the Basalt relieves, with undulating slopes of rich agricultural soil, the usual sterile character of a Carboniferous area. From Kiama to Sydney, cliffs of sandstones of the coal-group afford sections showing the gradual ascent into upper beds, the "Hawkesbury Series" of Clarke, on which Sydney stands. Crocodile Head, six miles north from Jarvis Bay, is a worthy subject for an artist's pencil, so picturesque is the grouping of these rocks at that particular point. From Sydney to Newcastle, bold bluffs of the same formation give facility for studying this part of the series. From Newcastle to Stony Creek is but a short trip, and as there are sections on which Mr. Clarke bases his evidence of the Palæozoic age of part, at least, of the New South Wales coal-seams, it is one of the necessary pilgrimages for the wandering geologist in search of truth. What I saw there I will state in as few words as possible. I saw three shafts on Mr. Russell's estate—ladder-shaft, working-shaft, and 200 ft. shaft. Ladder-shaft is 19 ft. below the level, and 132 ft. west of working-shaft. Working-shaft is 9 ft. below the level, and 360 ft. north-west of 200 ft. shaft. The dip of the strata is east 6° south. Taking working-shaft as a pivot, ladder-shaft is 6°, and "200 ft." shaft 39° off the line of dip. Reducing these distances between the shafts to the corresponding distances on the dip, we have—ladder-shaft distant from working-shaft 132 ft. nearly, "200 ft." shaft distant from working-shaft 280 ft. For details of the various strata passed through in these shafts see Clarke's 'Discoveries in Australia,' p. 53. Four coal-seams were cut in the several shafts. We may distinguish them as the 5 ft. 7 in. seam, splint seam, working seam, and bottom seam. Now the working seam, No. 16 and 18 of Clarke, is removed between ladder and working shafts. The top of this seam is struck in ladder-shaft at 24 ft. 4 in., and in working-shaft at 92 ft. 4 in. The difference in level being 19 ft., will therefore give a dip of 49 ft. in a horizontal distance of 132 ft., or the relation of perpendicular to base of 1:2·7=dip of over 20°. As 5 ft. 7 in. seam crops at the surface of ladder-shaft, it will not afford safe data for calculation of dip between it and working-shaft. In "working" shaft top of 5 ft. 7 in. seam is met with at 60 ft. 9 in. from the surface, in "200 ft." shaft at 153 ft., or, subtracting 9 ft. for difference of level, at 144 ft. This gives a difference of 83 ft. 3 in. in 280 ft. horizontal distance, or the relation of base to perpendicular 1:3·363. In "working-shaft," bottom of working-seam, with 2 ft. parting of sandstone, is reached at 97 ft. 10 in., to which add 9 ft. difference of level = 106 ft. 10 in.; and in "200 ft." shaft bottom of same seam, with 5 ft. parting of sandstone, is reached at 187 ft. 1 in., which gives a difference of 80 ft. 3 in. in 280 ft., or relation of base to perpendicular 1:3·48. It will be seen from these figures that a higher dip prevails between "working" and "ladder" than between "working" and "200 ft." shafts, and also that the strata intervening between "5 ft. 7 in." and "working" seams vary in thickness, and that we cannot deal as with straight lines in the calculation of the general dip. I have therefore taken the mean between the dip of the "5 ft. 7 in." and "working" seam, between "working" and "200 ft." shafts, as the nearest approximation for calculating the outcrop of the different strata. This is 81 ft. 9 in. in 280 ft. The relation of perpendicular to base 1:3·425 = 16° nearly. This places the outcrop of the lowest stratum (Clarke's No. 25) at a point 993 ft. S. 6° W. from the top of Russell's "200 ft." shaft, supposing the surface of the ground at the same level. Outcrop of top of bottom seam, 794 ft.; ditto, working seam, 611 ft.; ditto, splint seam, 573 ft.; ditto, 5 ft. 7 in., 524 ft. And these are the positions assigned for the various outcrops in the accompanying plan and section. When the details of these shafts were first made known by Mr. Clarke as a proof of the Palæozoic age of the coal, *Spirifera Fenestella*, etc., being found in abundance above, and Glossopteris associated with and below the coal, it was suggested by Professor M'Coy, that the data given by Mr. Clarke showed the existence of a fault between "working" and "200 ft." shaft. and that possibly to this fault the reversion of beds might be due, but the Palæozoic character of the fauna was not called in question. This error arose from taking the absolute distance between the shafts (360 ft.) instead of the reduced distance to the line of dip of 280 ft. Referring to the extension of Russell's coal-seams to the northern railway, unfortunately at a point where no marked bed of Russell's series can be absolutely identified, we have an apparently unbroken series of strata dipping in the same direction, and at about the same angle, as those in Russell's coal-pits, extending from a point at 19 miles 72 chains from Honeysuckle Flat to 21 miles 37 chains from the same place, the beds furthest to the eastward dipping at a greater angle. This affords a thickness (taking the angle of dip at 16°) of 2365 ft. of strata, abounding in fossil fauna from bottom to top, very low down in which coal-seams with Glossopteris occur. Fossils from each of the cuttings on the railway and from Russell's shafts were procured, that palæontologists may satisfy themselves of their European parallel. If it be admitted that the fauna found in the upper strata of these shafts is Palæozoic, then these coal-seams, at least, are Palæozoic, and Glossopteris has a much lower range than has hitherto been assigned it, except by Mr. Clarke. Neither does there seem any reason why Mr. Clarke should not place the Newcastle coal-seams (his No. 3 Carboniferous group) in the upper portion of this Stony Creek group, no known unconformity existing, since no fauna or flora typical of the Mesozoic period has, I believe, yet been found in the said No. 3. This brings me to the consideration of Mr. Clarke's present arrangement of the Carboniferous series of New South Wales. First. "Wianamatta beds" with insignificant coal-seams, the upper beds of which are the probable equivalents of our Otway, Bellerine, and Wannon beds, in which Glossopteris has not yet been found. Second. "Hawkesbury beds," with insignificant coal-seams, and no Glossopteris. To this series Mr. Clarke refers the Grampian sandstones of Victoria, though Mr. Selwyn places them with No. 4. (By Grampian sandstones I mean the beds constituting the sierra.) Third. "Carboniferous beds," containing the workable coal-seams, with Glossopteris by far the most abundant fossil. In the lower portion of this series, four known coal-seams are interpolated with strata containing a fauna similar in character to that found in the Carboniferous Limestone of Europe. Fourth. "Lepidodendron beds," not associated with coal-seams as far as yet known. If this arrangement is correct, and my experience as a field geologist is entirely in its favour, it is of great practical value to us in Victoria in the search for workable coal-seams, and should cause us to direct our attention to the upper beds of the Avon series, Gipps Land, where No. 4 is so well developed, and also to Cape Liptrap, where Carboniferous Limestone is supposed to crop out, in the hope of finding the Glossopteris beds. It points unfavourably towards the Tenæopteris and Zamites bearing beds, which we have hitherto regarded as our coal-producers, but which, as yet, have yielded nothing better than the Cape Paterson seams. 4000 feet also of these same beds have been tested by boring in the Bellerine district and have yielded nothing approaching a workable seam.

In the collection of fossils forwarded by Mr. Clarke to Professor M'Coy, at Cambridge, specimens had been collected from the three upper divisions of the Carboniferous series of New South Wales; the subsequent division of the group had not then been worked out by that indefatigable geologist, and it is in this way, I believe, the mistake has arisen between Mr. Clarke and Professor M'Coy. Whether the fauna that overlies Russell's coal-seams is most assimilated to the Palæozoic or Lower Mesozoic forms of Europe, is a question on which I am not competent to form an opinion. When the question shall have been settled by palæontological authorities, it seems to me that little will have been done for the physical geologist at the antipodes, who must trust to the order of superposition, rather than to the palæontology, to work out the order of sequence, holding the opinion of Professor Huxley, that "there is no escape from the admission, that neither physical geology nor palæontology possesses any method by which the absolute synchronism of two strata can be demonstrated. That the moment the geologist has to deal with large areas, or with completely separated deposits, then the mischief of confounding homotaxis, or similarity of arrangement which can be demonstrated, with synchrony or identity of date, for which there is not a shadow of proof, under the term of contemporaneity, becomes incalculable, and proves the constant source of gratuitous speculations." All the facts that we have to guide the field-geologist in Victoria in his search for Clarke's No. 3 Carboniferous beds (containing the workable seams of New South Wales) are these,—that they are very low down in the Carboniferous series; that the lowest beds contain a fauna nearly allied to the Lower Carboniferous of Europe; that Glossopteris is associated with all the coal-seams, and is the most common and characteristic fossil of the said No. 3. This peculiar fauna or flora has not yet been observed in Victoria. Leaving now this most interesting piece of country and coasting along to Moreton Bay, under the lighthouse on Moreton Island we have sandstones, with a slight inclination, apparently, of the Carboniferous series cropping from under the Tertiary (?) sand of which the island is composed. If this is really Carboniferous Sandstone, Moreton Island may shortly become more valuable than its outward appearance would lead one to suppose. The rocks on which Brisbane stands may be referred to the Upper Silurian; they have generally a north-easterly dip at high angles, are traversed by numerous quartz veins, and gold would surely be found, though perhaps not in workable quantity, in the gullies around the city. If not covered by the Carboniferous series, as in the neighbourhood of Ipswich, we should expect richer deposits of gold in a south-westerly direction on getting into rocks lower in the Silurian series, that is supposing them still to retain their north-easterly dip. Passing out of Moreton Bay, and still going northerly, Tertiary sands of the Brighton series occupy low-lying country on the coast, the Glass House Peaks, said to be volcanic, raising their peaked heads from the plain with sharper outline than the craters of Ascension. At Double Island Point, the southern entrance of Wide Bay, Basalt underlies the Tertiary, and hence to Inskip Point are cliffs the exact counterpart in lithological character of the Red Bluff series, Brighton. The streets of Maryborough are metalled with soft sandstone, similar in appearance to the Melbourne beds, and fifteen miles in a south-westerly direction gold of a nuggety character is being found in quantity, and about a hundred diggers are employed.

Hence to Rockhampton the sandy tertiaries prevail along the coast. Under Woody Island, and at one point on Fraser's Island, Basalt is seen in places cropping from under the sand. Rockhampton stands on rocks which dip to the north-east at high angles. A quarry opened at the side of one of the streets exposes a fine section of these. They consist chiefly of altered slates with bands of impure limestone containing fossils, pronounced by Professor M'Coy as Palæozoic. The altered slates, almost Lydian stone in places, resemble those of Mount Staveley, Victoria. No quartz reefs were noticed in them. In the range of hills opposite Rockhampton, these same beds have a westerly dip, and splendid sections are afforded of the sequence of beds in the heads of the creeks running from these hills. Up the Fitzroy, about four miles above Rockhampton, a marble is quarried for lime-burning; it has a north-easterly dip, and appears to be nearly the uppermost stratum of the series exposed in the neighbourhood. Cornelians, some of large size, are found in the gravel drift of the Fitzroy at this point, probably washed from granitoid rocks exposed higher up that stream. Leaving Keppel Bay and going north among the islands, all is granite (Pentecost Island is one of the most remarkable in form). Generally they are pine-clad, and have a most picturesque appearance. The sail from Rockhampton to Port Denison is, indeed, one of the most charming it has yet been my fortune to undertake. Rounding Gloucester Island, a precipitous granite ridge, Port Denison, is reached.

The township of Bowen stands on Tertiary sand resting on a granitoid rock. The same geological feature extends along the coast northward to the Burdekin river, Cape Upstart, Mount Abbot, and numerous smaller peaks of granite rearing their heads above the Tertiary plains and alluvial swamps at their base; indeed, were the coast line submerged to the dividing range 200 ft. below the present level, it would present the same features as now obtain from the present shore to the Barrier Reef. At the lower crossing of the Burdekin, the cornelian-bearing granitoid rocks are again in force, and abundance of cornelians are to be found in the river sands. Following the present well-beaten track to the Valley of Lagoons at the head of the Burdekin—a track which twelve months ago did not exist, but is now as plain and well-worn as any in Victoria (the distances in miles marked on the trees)—for twenty-nine miles from the Lower Burdekin crossing, we pass over a level, sandy, Tertiary area, with large patches of swampy alluvium. At the twenty-seventh milestone Kill Bullock Creek is reached, on the east bank of which a well-defined quartz reef crops out from a matrix of rotten granite. This granite is exactly similar in character to that of Omeo and that of some portions of Tambo

River, Gipps Land. Frequently hornblende replaces the mica altogether; it is then this rotten character is most observed, and the decomposition itself has been so active in places, that at the forty-first milestone a freshwater deposit of white limestone has accumulated to a very considerable thickness. At the forty-second milestone the summit of the coast range is reached. Hence to the fifty-third milestone, the last crossing of the Fanning river, these same granitoid rocks prevail. In the bed of the Fanning river gold of rather coarse character has been found, both by Mr. Ross, of the Fanning, and a party of miners who accompanied Mr. Brown, of Sydney, to open a supposed copper-lode in the neighbourhood. [The specimen given me by Mr. Brown was examined by Mr. Wood, at the Geological laboratory, and found to be specular iron ore.] Now this is exactly the character of granite described by Mr. Clarke, of Sydney, as gold-bearing; in fact it was from the description in his 'Southern Goldfields,' that I was led to give more than ordinary attention to this area, in hope of getting at some practical result.

My time would not permit me to prospect for myself, but I am of opinion that a less lucrative employment might be found than gold-washing in Kill Bullock Creek, and from there to the Fanning river the geological indications are equally favourable, supposing it to be a fact that granite of this description, or even quartz reefs in granite, are the matrix of gold. It is true that on the top of the coast range boulder-pebbles of rocks foreign to those *in situ* are scattered over the surface of the ground, and although denudation over this area has been very great, still I saw no sign of Silurian rocks in or near the Fanning; there are certainly none on the east side coast-range. This looks like one more example of the occurrence of "gold in granite." At about the seventieth mile from the Lower Burdekin crossing, the granites give place to limestones full of corals, with a lithological character, the exact counterpart of those of Buchan and Bindi, Gipps Land; they are as much contorted as these, but their most regular dip is N. 30°, E. 50°. The same physical outline is also here obtained, and Bindi, dotted with small clumps of scrub, overgrown with many-tinted creepers, to give variety to the landscape, would serve for a photograph of Cunningham's Burdekin Station. These limestones were either very thin originally or they have been greatly denuded, since the granite crops at the surface at intervals till we lose it altogether, and at the Upper Burdekin crossing regularly stratified pink and brown sandstones and breccias make their appearance, dipping south-westerly at an angle of 10° to 15°.

On the west side of the Burdekin, Basaltic lava veils the underlying rocks, but on crossing a deep cutting creek, six miles from the crossing place, these same pink sandstones occupy the bed of the creek, with a westerly dip at 15°. These sandstones I take to be the northerly extension of the Carbonaceous series, which I have Mr. Gregory's authority for stating extend from the junction of the Suttor with the Burdekin to Darling Downs. The usual section on the Buckland table-land, according to this authority, is—1. Basalt; 2. Upper Carboniferous Sandstone; 3. Coal-measures; 4. Limestones, with spirifers. I am indebted to Mr. Richardson, of Rockhampton (of Burns, Bassett, and Co.), for the information that a seam of coal 6 ft. thick crops in the banks of the Mackenzie, near Cooroorah station, with a general S.W. dip, resting unconformably on the conglomerates and sandstones of Mount Stewart.

From this Upper Burdekin crossing west to the watershed of the Flinders the country is entirely basaltic, Fletcher's Creek forming its main boundary on the south, and the Clarke river on the north, where the underlying rock is seen in the bed of "Basalt" or "Limestone" creek; it is of a granitoid character, but Mount Caroline, the southernmost peak of Perry's Range, is of altered slate, highly inclined, with numerous and broad quartz reefs on the flanks, the summit being composed of syenite, and this appears to be the character of the rocks of the Upper Clarke, though blue fissile slate with quartz reefs is more abundant there. Mr. Clarke has long ago pointed out this district as a future gold-field. The fulfilment or otherwise of the prophecy is at hand. It was from drifts overlying the Basalts of this district I obtained the bones of Diprotodon, the most northern part of Australia in which, at present, the fossil remains of this animal have been found. It is to these drifts that the cattle in the neighbourhood come to lick, and I am of opinion it is more for the phosphates from the bones of Diprotodon and his allies than from the chlorides they contain.

A well-defined crater exists at a point bearing S. 30° W. from Mount Caroline, distant 36 miles. From the top of this an excellent view is obtained of the boundary of the Basalt to the south. Granite spurs, gradually sloping to the southern side of Fletcher's Creek, have checked its further development in this direction.

Looking westward, we have a gradual rise to the table-land forming part of the watershed between the Flinders and Burdekin rivers, broken at intervals by low isolated peaks or ridges. From this point may be seen the Mount Mayne, etc., of Walker. South of this hill, about two miles, commences what is called a "Basalt wall." This is said to extend in a south-easterly direction as far as, and across, Fletcher's Creek, and I believe no one had up to that period penetrated above this up Fletcher's Creek. Where I struck it it had the appearance of a walled city ruined by an earthquake, the outer wall, though much rent, preventing the access of a horseman to the débris lying within. Creepers and shrubs of great variety grew over all, whilst a swampy bog at the base of its bluff margin, rich in ferns, promised on the whole a harvest for the botanist, a safe retreat for the blackfellow, and charming "little bits" for the artist or photographer. I regret much that I could not devote the time to following down this "Basalt wall," and more thoroughly exploring it. Whether it is the margin of an enormous crater, or a more recent lava-flow than that of the surrounding level country, I had not leisure to investigate. These Basaltic Lavas differ in no respect from those of probably the same age in Victoria; a suite of specimens collected on Keilor Plains and on the Upper Burdekin could not be distinguished the one from the other. A peculiar feature of the Basaltic country here is, that the banks of the main, deep-cutting creeks are very rocky, whilst the branch creeks are usually the drains of open, gently-sloping well-grassed downs; table-lands of lightly-timbered and usually coarser-grassed country intervening between the branch creeks. The timber on these table-lands is chiefly that known as "stunted ironbark," and a remarkable feature is the absence of fallen timber. This is attributable to the fact that the centre of nearly all the trees is hollow, making them an easy and certain prey to the first bush-fire.

Taking a general view of the geology of Queensland, as far as could be obtained in such a flying visit, and from the reliable information I could collect, it would appear that a belt of Upper Silurian rocks extends along the coast from Brisbane to the neighbourhood of Broad Sound, and that their strike being nearly parallel with the coast line, has mainly determined its outline. Their dip, where observed, is north-easterly, at a high inclination. The Maryborough and Rockhampton beds I would place at about the same geological horizon; lower in the series would come the gold-fields of Canoona, and those south-westerly from Maryborough, and to the strip of country beween these two gold-fields we should look for the extension of diggings. From the fact of these rocks being, as I believe, Upper Silurian, gold-fields of the type of Caledonia and Anderson's Creek are to be expected rather than those of Sandhurst and Ballarat. Silurian rocks again make their appearance at Mount Caroline, the southernmost peak of Perry's Ranges, Upper Burdekin. On the flanks of this hill their general dip is south-westerly. These rocks I should consider about the horizon of the auriferous series of Peak Downs, and that they represent the western portion of a great anticlinal axis, of which the Canoona and Maryborough beds represent the eastern. The dome of this axis has been denuded, and gone to form a portion of the material of that enormous carboniferous deposit which, as Mr. Gregory informs me, extends from the junction of the Suttor with the Burdekin southward to Darling Downs. From Broad Sound northerly to Mount Elliot, the coast range is of granite and its varieties, and in streams flowing exclusively through the granite, auriferous drift is found.

Whether the extension of the Silurian system over this country has been entirely removed, and the granite represents only the base of this supposed anticlinal dome exposed by denudation (as the objectors to gold in granite would probably argue), is, of course, uncertain; this much at least can be said, that the drift in which this gold is found is essentially granitic, and the resemblance to the granites of Omeo and Tambo River, Gipps' Land, is remarkable. Basaltic lava flows, of greater or less extent, are met with in various parts of the colony, *e.g.* between the Clarke river and Fletcher's Creek, the Valley of Lagoons, the Buckland table-land, Peak Downs, etc. Between the 19th and 20th parallels of latitude the greater part of the country seems to be occupied by it. The tract of country included between the Clarke and Fletcher's Creek has received its Basaltic covering from local craters, which form conspicuous landmarks only from high ground; they are too low to be seen in timbered country. The Basaltic areas are those best adapted for pastoral purposes in the tropics, their rich soils inducing the growth of the finer grasses with abundance of herbs, whilst their elevation above the sea renders the climate less enervating than that of the seaboard. From Mr. A. C. Gregory I learn that the representatives of our "older Basalts" of Philip Island, Cape Schank, etc., are found as dykes cutting through the Carboniferous series, and he draws the distinction (which holds in Victoria) between the Basaltic lavas of the plains and these, that the former were ejected from individual craters, the latter from fissures, forming dykes in rocks they traversed.

The geology of Queensland, therefore, seems to differ little from that of Victoria, except in the relative areas occupied by each formation, the neighbourhood of Fitzroy Downs, from which the Wollumbilla fossils have been received, affording the only prospect of novelty to the Victorian geologist.

NOTES AND QUERIES.

Devonians in North-East France.—It is well known that the Devonian rocks of the Meuse extend towards the Boulonnais, and are connected with that enormous line of dislocation and upheaval which has brought up the coal-measures and subjacent rocks in a direction from

Tournay to St. Omer. The researches of M. Gosselet, which have been recorded by him in a most able memoir on the Palæozoics of Belginm, published in 1860, and a few communications made by him to the Geological Society of France, leave little to be desired, either on the score of descriptive or comparative geology. Led by a desire to ascertain how far the appearance of the rocks representing the uppermost strata of the Devonian there shown agreed with our own Devonshire types, I made recently a brief excursion to Avesnes and Oltrungt. The former place may be reached by a pleasant walk of about four miles from Aulnoye, a station on the line to Maubeuge, or by country *diligence* from Landricies. On getting out of the Neocomian plains covered with loamy soil into the more diversified country near Avesnes, the cuttings begin to show a shivered rock of a snuff-brown colour, having a Devonian facies. The road-metal is evidently carboniferous limestone. This continues into the town, and thence southwards by the great road for about two miles, when a black massive limestone crosses the road, and is worked in the field adjoining in vertical beds. Fossils are scarce, but the series of beds are like those of Newton Bushel. Proceeding on to Oltrungt, and visiting the quarries so well described by M. Gosselet, we have undoubtedly the South Devon limestones and shales in full force, with abundant fossils. There are a few fossils of the Upper Devonian (Clymenia), and some of the Petherwyn forms, but on the whole the group is that of Plymouth and South Devon. The copious lists of M. Gosselet will furnish comparison with our own localities. The junction in the carboniferous limestone with the Devonian is nowhere shown, though quarries in each formation are wrought near to each other. But it is impossible for any one acquainted with the aspect of the latter in our own country to confuse the two here, as was done for many years here. The former is of the Tournay type, and characterized by *Productus semi-reticulatus* and other Tournay forms. The Devonian, as a whole, is characterized by *Phacops latifrons, Spirifer Verneullii, Orthis crenistria*, etc.

I had only a day to devote to Oltrungt, but it would repay a longer stay, and the extensions of the beds on the line of strike well deserve study. I could not detect any true apparent Devonian, or any Carboniferous beds below the Tournay limestone.—S. R. Pattison.

Boulder Drift at Marlborough.—In a personal note, Mr. Whittaker, of the Geological Survey, says, "In your review of Flora of Marlborough, I think you give a quotation, in which the Boulder Drift is said to occur in that neighbourhood. There is nothing of the sort there, and I expect that the faults noted are purely imaginary."

Errata.—In the description of the section, Plate I., Fig. 1. instead of "Section from Furze Hill to Farringdon," *read* "Section from Little Coxwell eastward, passing through the pits of Sponge and Red Gravel."—C. J. H. Meyer.

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ON SPIRAL PLANETARY ORBITS AND THE PHYSICAL EFFECTS OF A RETARDATION OF THE EARTH.

By the Editor.

When we see the untenable deductions to which even such an eminent man as Professor Frankland is led, in his new glacial doctrines,* by basing a meteorological hypothesis upon the unproven basis of a central molten core in our planet, we cannot but be the more convinced of the necessity of reconsidering the theories and hypotheses which have been proposed to account for the origin and supposed early conditions of our earth. We have been called upon by geologists to reject the Mosaic cosmogony because its statements were not coincident with geological facts, and equally now are we called upon to examine what those asserted geological facts are, and whether the asserted superior theories of geologists are substantially correct, or whether they are one whit less mythical than the traditions of aboriginal peoples.

Because men saw what through their telescopes looked like luminous clouds, the elder Herschel and Laplace assumed the idea, still later urged by Nichols, that these celestial nebulæ were vast masses of ethereal vapours condensing into stars. Modern telescopes, however, constantly being increased in size and power, have resolved one after the other of these into wonderful star-systems—dust-clouds of brilliant suns. And has not every one of these far distant stars non-luminous planets and worlds rolling round it, as our earth and its sister-planets round our sun? As baseless then as the fabric of a vision is the nebulous theory, ingenious undoubtedly and creditable to its authors as a suggestion, but every tittle of evidence to support it has vanished, and left not a wreck behind. We ask the supporters of this doctrine—for many still there are—to point out an instance of the evolution of light and heat by *slow* condensation of gaseous matter? If we fire hydrogen and oxygen, the condensation assumes the form of an explosion, light and heat are generated in a sudden flash, and the resulting drop of water is formed. If then the materials of the earth were derived from the condensation of gaseous matters in space, that condensation would be of the briefest period of time, not enduring for unaccountable ages,—the formation of our globe rapid and suddenly consummated. Was it so? If by loss of heat in condensation the solid and fluid materials of our earth were thus resolved into a globe, heat must have been the cause of the previous expansion of those materials into a gaseous state. Whence, then, was that heat derived? In the interior of our earth, where every atom of matter is subjected to pressure and chemical action, it is easy to see that in the natural order of the correlation of physical forces, motion and heat must be produced. And so far it is certain that in the natural and unavoidable changes which are there going on, heat *equal* to any degree of temperature yet observed in the deepest mines, or the waters of the deepest wells, may be constantly generated and maintained. If we take the meteorites which have fallen upon our earth and examine them, even the smallest are composed of solid earthy or metallic substances. May not these meteorites be the nuclei of worlds? If iron, potassium, sodium be in vaporous incandescence round the sun, why may not metallic particles exist in space? If solid materials, whether in almost infinitesimally mechanically-divided, or in vaporous or gaseous states, exist in space, segregation by such atoms is inevitable. Two or three united together by mutual affinity and attraction, would gather in time two or three more, and so on rushing through space they would ever gather like the snowball in weight and volume as they rolled. May we not ask, is not orbital and celestial motion ordained for the very purpose of world-increase—the gathering and segregating of more materials? Take this view, and you have the greatest and grandest of worlds formed as placidly as a rain-drop, and the mind is relieved of the puzzling incongruities of luminous condensation without explosion, and of internal cores of molten rock in every planet, without any source of fire to keep the melting up from age to age.

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* See Proceedings of Royal Institution, page 105.

The notion of the resistance of the ether of space to planetary orbital motion, has been passing through other minds besides our own, and since we printed them we have read with much pleasure an article by Professor Henrichs, of Iowa, on the Density, Rotation, and Age of the Planets, in the 'American Journal of Science.' All the old astronomical notions of the old astronomers of the permanence of the heavenly orbs and the celestial system, still retained, and too closely and superstitiously adhered to, are based upon and must be based upon erroneous foundations. The permanence and endurance of heavenly bodies, and the perpetual rectification and everlasting persistency of their motions, must be based upon these assumptions:—1, that *space* is a *vacuum;* 2, that a body set in motion *in vacuo* will continue in motion *ad infinitum;* 3, that every form of motion must be an *accurate mathematical figure* perfectly and absolutely true, such as a circle, an ellipse, a straight line; and lastly, that there must never be any transportation or intercommingling of even the merest particles of matter between one world and another, nor *the least loss nor the least gain of material* from any planet or sun whatever, from the beginning to the end of time. The world at its creation must have been weighed in the balance, and not an ounce nor a feather's weight added to it since. Now we know there is ether in space; if there were not, the light of the sun would have no material to vibrate upon, and though the sun burned with ten times its glorious brilliancy, all would be darkness here, for it is scarcely possible to believe that light could travel in an absolute vacuum. We never get, experimentally, a perfect vacuum, pump as hard as we can; fit the joints of our instrument as close as we may, we never get one. It is always an atmospheric vacuum, a nitrogen-vacuum, a hydrogen-vacuum, an ether-vacuum,—always some residue; never a vacuum at all, however near it may approach,—always some material particles, no matter how expanded, for the vibration of light to thrill along, and this the electric spark and the spectrum-prism will always show. If the ether of space exist,—and astronomers who adhere strongest to the old notions admit it,—there must be resistance. The more subtle the ether, the more delicately slight the resistance, but still resistance; and with resistance comes friction, with friction retardation and the evolution of heat. With retardation of orbital motion the diameter of the planet's orbit must be contracted. The world might—most probably would—run round the sun up to the very same line, radiating from our luminary to the same hour, minute, and second, but not to the same spot, but to a spot nearer, no matter how slightly nearer, to the sun, although upon the same straight line, and so year by year the circumference of the orbit would be ever constantly contracting; and what must be the inevitable result?—a *spiral* orbit!

Now, let us consider what would be the physical results of this retardation producing a spiral orbit. If the retardation be ten feet annually,—we will take it hypothetically as such for the present, and to still further simplify the proposition we want to put, we will also take for the present a perfectly circular orbit, because by so doing we shall get a total result *at once*, instead of having to eliminate a total result from a period of duration. If the earth be retarded ten inches a month, the total retardation would be ten feet for the year, so we may assume, for simplicity of explanation, a full total at once. Now, then, if the earth were thrown back in her orbit suddenly for ten feet, what effect would her momentum exert upon her constituent material particles? Would not every one of these particles have a tendency to fly on, and would not this tendency produce tension and inter-particle motion, and thence, of course, friction, rearrangement, crystallization, upheaval, and subsidence of masses, and *internal heat?* Has the internal heat of our globe any other source than results from the constant retardation of our earth in a spiral orbit? And is not the primary physical force which evolves all, or principally all, structural alterations and constituent rearrangement of rock-masses? And if so, is not this force calculable? If the earth be retarded ten feet per annum, will not this force be equal to the momentum of the mass of our globe for the time our globe takes to pass through ten feet of space? Given this rule, can we not estimate the quantity of heat that would be evolved? It seems to me we can; and as by such a cause the temperature of the *whole* of the interior of the earth beneath that mere rind, subject to solar and atmospheric variations, might be and would be equally warmed to a certain point, whatever that may hereafter be determined to be, and thus the internal heat would be naturally accounted for by natural phenomena. And even if it should be found that this cause should be a sufficient source for an intense degree of heat,—and it is possible it may be,—we should be relieved of much of the embarrassment which the internal heat theory provokes, because we never can get its theorists to assign a natural and intelligible cause for its production and maintenance.

ON THE FORAMINIFERA OF THE LONDON CLAY.

By Professor T. Rupert Jones, F.G.S., and W. K. Parker, Esq.

In 1833, T. N. Wetherell, Esq., of Highgate, discovered several Foraminifera in some London Clay taken from a well at the Lower Heath, on the south side of Hampstead; see Proceed. Geol. Soc. vol. ii. 1834, p. 93, and Transact. Geol. Soc. 2 ser. vol. v. p. 131. In plate ix., one of the two plates accompanying Mr. Wetherell's paper in the Geol. Transactions, these Foraminifera, with other small fossils from the clay, were figured by Mr. J. De C. Sowerby, by whose help also the determination of the fossils was made.

At page 135 of Mr. Wetherell's paper, the figured Foraminifera are referred to as "Nodosaria, pl. ix. figs. 3–7; Articulina, figs. 8–10; Marginulina, fig. 12; Rotalia, figs. 13–18; Cristellaria, fig. 19; Miliola, fig. 20." Fig. 11, doubtfully referred to "Frondiculina," is not a Foraminifer, but probably the cast of the palettes of a *Teredo;* a similar fossil is figured and thus designated by D'Archiac in the Mém. Soc. Géol. Franc. We have seen, in Mr. Wetherell's collection, the Foraminifera from the well above-mentioned, as well as others from the London Clay of Hampstead, Highgate, and Finchley. We possess a large series of picked specimens collected by Mr. John Purdue from the London Clay of the Copenhagen Fields, Islington, when the cuttings for the Great Northern Railway were being made; also some from the London Clay of Finchley, Chelsea (bed of the Thames), and Clapham; and a very fine suite of specimens from Wimbledon Common (out of the clay at about 100 feet in depth). The last-mentioned series is probably a nearly complete local Foraminiferal fauna; for very many pounds of the clay were minutely examined, and there are only one species, and three varieties of two other species, to be added from our other gatherings from the London Clay.

With regard to the figured specimens from the well near Hampstead, the following is our determination of the species and varieties; most of the latter, however, as well as the real species, have distinct names, as is common and convenient with Foraminifera:—

Geol. Trans. 2 ser. vol. v. pl. ix. fig. 3. *Dentalina Buchi*, Reuss, d. g. Ges. Zeitsch. ii. pl. iii. fig. 6. The specimen, still preserved by Mr. Wetherell, shows the characteristic, minute, longitudinal riblets crossing the septal constrictions, but not seen in the figure. This is not an uncommon variety in some Tertiary deposits.

Fig. 4. *Dentalina elegans*, D'Orb. Foram. Foss. Bas. Vien. pl. i. fig. 52. This is a fragment of one of the manifold subvarieties or individual modifications of *D. communis*, D'Orb., which has abundant representatives in the living and fossil states.

Fig. 5. *Dentalina spinulosa*, Montagu, Test. Brit. Suppl. pl. xix. fig. 5, p. 86. A fragment, figured upside down. A similar fragment, figured and described by Montagu, obtained by Mr. Boys from the

sea-shore of the south-east of England, and long thought to be recent, has been referred by us to the London Clay. (Annals Nat. Hist. 3 ser. vol. iv. p. 346.) Differences in the development of the little prickles constitute the chief distinctions of the closely allied forms *D. spinulosa*, Montagu, *D. Adolphina*, D'Orb., *D. spinescens*, Reuss, *D. spinosa*, D'Orb., and *D. spinicosta*, D'Orb., in all of which the longitudinal riblets, so characteristic of well-grown Nodosarinæ, are modified as spines and prickles; whilst in another closely allied set of forms, the prickles are less regularly arranged in rows, and of varying strength; namely, in *Nodosaria hirsuta*, D'Orb., *N. rugosa*, D'Orb., *N. punctata*, D'Orb., *N. aculeata*, D'Orb., *N. hispida*, D'Orb., *N. conspurcata*, Reuss, *N. aspera*, D'Orb, *Dentalina aculeata*, D'Orb., *D. floscula*, D'Orb., *D. scabra*, Reuss, *Marginulina hirsuta*, D'Orb., and *M. cristellaroides*, Czjzek. The modifications of form, from the straight Nodosaria, through the bent Dentalina, to the still more curved Marginulina, do not any more represent *specific* differences than the modifications of the exogenous riblets and prickles. Nor do the differences in the relative size and gibbosity of the chambers afford more distinctive characters; but all these features are subject, one with another, to endless gradual transitional modifications in the Nodosarinæ. *D. spinulosa* and its subvarieties are exceedingly common in the London Clay and in the Septarien-Thon of Germany and other Tertiary beds.

Figs. 6 and 7. *Textularia (Verneuilina) communis*, D'Orb. The figures do not distinctly exhibit the peculiar triangular apex of the shell; a feature arising from its being at first a triserial *Textularia* (*Verneuilina*), before it grows with a single line of chambers only, so taking a Nodosarian shape. The shell is rough with grains of sand cemented into its substance; a structure affected by Textularia and some other genera, but not by Nodosarina. It was mistaken by one of us for a Nodosaria, and named *N. rustica*, Jones, in Morris's Cat. Brit. Foss., 1854, p. 37; and Montagu evidently had specimens (derived from the London Clay) before him when he described and figured the "Nautilus Radicula," Test. Brit. p. 197, pl. xiv. fig. 6 (not pl. vi. fig. 4); see Ann. Nat. Hist. 3 ser. vol. iv. p. 344 and p. 350. This elongated dimorphous Textularia is one of D'Orbigny's Clavulinæ (*Clavulina communis*, For. Foss. Vien. pl. xii. figs. 1, 2); other "Clavulinæ" are elongated Uvigerinæ and Valvulinæ (see Ann. Nat. Hist. 3 ser. vol. v. p. 469). This little Foraminifer is very common in the London Clay and in some other Tertiary deposits; and it still lives in the Mediterranean.

Fig. 8. *Nodosaria Badenensis*, D'Orb. For. Foss. Vien. pl. i. figs. 34, 35. This is a modification of the usually more regular *N. Raphanistrum*, Linn.; indeed, the increase of size in some of the chambers is so variable, that there is no real ground for the separation of this from the next form, with which it is associated in considerable abundance in the London Clay, and several other Tertiary deposits. The specimen figured is a fragment.

Fig. 9. Three chambers of the long, cylindrical, ribbed *Nodosaria Raphanistrum*, Linn., the same as *N. Bacillum*, Defrance, *N. æqualis*,

Sow., *N. affinis*, D'Orb., etc. Common in the London Clay, the Vienna basin, the subapennine Tertiaries, the Malaga, San Domingo, and other clays, and recent at Jamaica.

Fig. 10. *Nodosaria Raphanus*, Linn. This is less developed compared with the foregoing, and is equally, if not more abundant in the recent and fossil state. Its modifications are endless, and its names proportionally numerous. There is no real demarcation either between *N. Raphanus* and *N. Raphanistrum*, or between them and their subvarieties, however modified as to size and number of riblets, closeness or division of the chambers, conicity or cylindricity of the shell, its straightness or curvature, or the more or less central position of the aperture. Gradual changes lead us, on one hand, to the costulate and prickled Dentalinæ and Marginulinæ above referred to; and, on the other, to the smooth *Nodosaria radicula* and *Dentalina communis;* whilst Vaginulinæ, Marginulinæ, and Cristellariæ, with and without riblets, come out, as it were, from the straighter forms without any real *specific* differences, however convenient it may be to retain distinct names for nearly all the modifications alluded to.

Fig. 12. *Marginulina Wetherellii*, Jones, in Morris's Catal. Brit. Foss. 1854, p. 37. Montagu had this little shell also in the Boysian Collection, doubtlessly from the cliff-washings of Kent, and referred it, erroneously, to what is now known as a narrow variety of *Peneroplis planatus*. It is one of the most common of the Foraminifera of the London Clay, and though somewhat similar Marginulinæ occur in other Tertiary beds (San Domingo), and even in the Chalk (of Mecklenburg),* and the Clays of the Oolites, yet it remains as a distinct variety. It had a peculiar habit of ending its growth with one or more simple, contracted, smooth, dentaline chambers, figured both by Montagu and Sowerby.

Fig. 13. *Cristellaria cultrata*, Montfort. A common, nautiloid, keeled Cristellaria, common in many deposits, both of Secondary and Tertiary age, and abundant in the living state in the existing seas at many places. When the keel is wanting, we have *C. rotulata*, Lamarck; when the shell is large-keeled and rowelled, it is *C. Calcar*, Linn.; when flattened and broad, it is *C. Cassis*, Fichtel and Moll.

Figs. 14–18. These little Rotaline shells are small varieties of *Planorbulina farcta*, Fichtel and Moll (Ann. Nat. Hist. 3 ser. vol. v. p. 177, etc.). They range between the varieties figured and described by D'Orbigny as *Rotalia Haidingeri* and *R. Ungeriana;* and Reuss's *R. ammonoides*, D'Orbigny's *R. Akneriana* and *R. Dutemplei*, are scarcely, if at all, divisible from *R. Ungeriana*. All of these abound in the present oceans. Another near modification of this form is shown in the well-known *Planorbulina (Truncatulina) lobatula*, Walker and Jacob, which also occurs in the London Clay, though not so plentifully as the foregoing, and frequents shallower water than they do.

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* *Cristellaria decorata*, Reuss, Zeitsch. d. g. Ges. vii. pl. viii. fig. 66, and pl. xix. figs. 1, 2.

FORAMINIFERA OF THE LONDON CLAY OF MIDDLESEX AND SURREY.

Genera, Species, and Varieties.	Wetherell's Collection.		Collections of Messrs. Parker and Jones.			
	Hampstead Well.	Highgate, Hampstead, Finchley, etc.	Copenhagen Fields, Islington.	Chelsea (bed of Thames).	Clapham.	Wimbledon Common.
Miliola (Biloculina) depressa, D'Orb.	...	...	...	...	...	rr. s.
——— *(Triloculina) oblonga*, Montagu	...	...	r. s.	...	...	rc. s.
——— *(Quinqueloculina) triangularis*, D'Orb.	+	+	c. s.	...	...	c. s.
Trochammina incerta, D'Orb.	+	...	c. l.	...	...	r. l.
Lituola nautiloidea, Lamarck	...	...	rc. rs.	rc. m.	...	...
Nodosarina (Nodosaria) Raphanus, Linn.	+	...	...	...	...	vr. vs.
——— ——— *Raphanistrum*, Linn., and *Badenensis*, D'Orb.	+	...	c. rl.	...	c. m.	c. rl.
——— ——— *Ovicula*, D'Orb., and *longiscata*, D'Orb.	...	...	c. m.	rr. m.	...	rc. rs.
——— ——— *Pyrula*, D'Orb.	...	...	rc. m.	rr. s.	...	rc. s.
——— ——— *Radicula*, Linn., and *humilis*, Roemer	...	...	rc. m.	rr. m.	...	rc. rs.
——— ——— *hirsuta*, D'Orb.	...	...	...	...	...	vr. s.
——— *(Dentalina) communis*, D'Orb., and *elegans*, D'Orb.	+	...	rc. rs.	c. rs.	...	c. s.
——— ——— *consobrina*, D'Orb., and *pauperata*, D'Orb.	...	...	c. m.	...	rr. s.	c. s.
——— ——— *brevis*, D'Orb.	...	...	...	...	...	rc. s.
——— ——— *Buchi*, Reuss	+	...	...	...	...	...
——— ——— *acicula*, Lam.	...	...	rc. m.	...	r. m.	rc. l.
——— ——— *spinulosa*, Montagu	+	...	c. m.	...	c. l.	c. m.
——— ——— *acuticosta*, Reuss	...	...	...	...	...	rr. s.
——— *(Vaginulina) linearis*, Montagu	...	...	...	...	...	rc. s.
——— *(Marginulina) Lituus*, D'Orb.	...	...	rc. rs.	...	...	r. s.
——— ——— *Wetherellii*, Jones	+	+	c. l.	c. l.	c. l.	c. l.
——— *(Cristellaria) cultrata*, Montfort, and *rotulata*, Lamarck	+	+	rc. m.	...	c. m.	c. l.
——— ——— *Cassis*, F. and M.	...	...	...	...	...	rc. l.
——— ——— *Italica*, Defr.	+	...	c. m.	...	...	...
——— ——— *Crepidula*, F. and M.	...	...	...	...	...	r. s.
Globigerina bulloides, D'Orb.	...	...	...	...	...	rr. s.
Pullenia sphæroides, D'Orb.	...	...	...	...	...	r. s.
Textularia agglutinans, D'Orb.	...	...	rc. rs.	r. s.	...	c. s.
——— *Turris*, D'Orb.	...	...	r. rs.	...	...	...
——— *abbreviata*, D'Orb.	...	...	...	...	...	r. s.
——— *carinata*, D'Orb.	...	+	rc. m.	c. m.	...	c. m.
——— *(Verneuilina) communis*, D'Orb.	+	+	c. m.	c. m.	...	c. l.
Bulimina ovata, D'Orb.	...	...	rc. m.	c. m.	...	c. m.
——— *(Bolivina) punctata*, D'Orb.	...	...	...	...	...	vr. s.
Planorbulina Haidingeri, D'Orb.	+	...	+ ?	rc. s.	...	c. m.
——— *Ungeriana*, D'Orb.	+	+	+ ?	rc. m.	r. s.	c. m.
——— *ammonoides*, Reuss	...	...	...	rc. m.	...	c. l.
——— *(Truncatulina) lobatula*, Walker and Jacob	...	+	...	...	...	r. s.
Pulvinulina elegans, D'Orb.	...	...	...	r. vs.	...	r. m.
——— *Micheliniana*, D'Orb.	...	...	...	...	...	rr. m.
Rotalia orbicularis, D'Orb.	...	...	...	r. s.	...	r. s.

Fig. 19. *Cristellaria Italica*, Defrance (D'Orbigny's Modèles,* nos. 19 and 85). This is not an uncommon form where Cristellariæ abound, either in the recent or the fossil state.

Besides the foregoing, we have seen *Trochammina incerta*, D'Orb., among the specimens from the Hampstead well, in Mr. Wetherell's collection.

The London Clay from Wimbledon Common was got at about 100 feet in a well-boring. That from Chelsea came from the foundations of the Battersea Park Bridge.

The Foraminifera of the London Clay indicate a depth of about 100 fathoms for the sea, in which it was deposited in this district.

The accompanying Table shows the Foraminifera that we have recognized in the London Clay, arranged according to the classification proposed by Dr. Carpenter in his 'Introduction to the Study of Foraminifera,' 1862. The asterisk indicates their presence merely (the relative abundance not being known); their frequency and condition are shown in some of the columns by the following letters:—*rc.* rather common; *c.* common; *rr.* rather rare; *r.* rare; *vr.* very rare; *vs.* very small; *s.* small; *rs.* rather small; *m.* middle-sized; *rl.* rather large; *l.* large. In some instances two very closely related, but still notable, varieties are mentioned together.

CUTTINGS FROM A NOTE-BOOK ON CHALK GASTEROPODS.

By Harry Seeley, F.G.S.

Two years ago, collecting matter for future use, in travelling over the Chalk-lands, I made, in the museums visited, such brief memoranda of striking fossils as might save the trouble of comparison with other specimens. The notes were never intended for publication in their present form, but as any more extended work on the subject is at present impossible, such of them as I have permission to print may be found useful to others engaged on similar work.

This series is part of the magnificent collection in the Brighton Museum; to the Committee of which I am indebted for the opportunity of making use of them.

CERITHIUM ORNATISSIMUM, *var.*

Conical, twice as high as wide. Many-whorled; whorls flat and narrow, being four times as wide as high. Each whorl is ornamented on the upper and lower sutural margins by a very numerous row of closely-placed tubercles. The anterior row has the tubercles elongated longitudinally; those of the posterior row are more bead-like. Connecting these rows are half as many again narrow, sharp, upright ribs. The tubercles and ribs become not only actually, but relatively much more numerous as the shell enlarges; they are crossed horizontally by a number of (about ten) fine spiral striæ. The base makes a right angle with the spire, as in many recent species it is prolonged much in front of the side of the whorl.

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* A set of these can be seen in the British Museum.

This form nearly resembles *C. ornatissimum*, Desh., and is possibly its lineal representative. The differences of ornamentation are such as constantly are produced by the conditions of existence. The unequal spiral rows of tubercles of *C. ornatissimum* become in this form equal, and pass round the spire contiguous, so as to conceal the suture. In this form the excessive multiplication of the elongated tubercles of the anterior row tends in the last whorl to make that row less distinct; a similar character is also to be noticed in the adult of the French species. The longitudinal ribs of this variety exist in the species from the Gault only as striæ. The basal prolongation of the lip is, however, a feature in the chalk-marl form which will keep the two varieties from being confounded.

A second slight variation is met with not rarely in the lower argillaceous chalk of Burwell, in Cambridgeshire. It more closely resembles the foreign type than the Brighton specimen. In it the posterior row of tubercles is placed on an elevated rib; while the anterior row, at least on the anterior half of the shell, is wanting, being represented by rather elongated thickenings of anterior ends of the very fine striæ which replace the longitudinal ribs.—(*Woodwardian Museum.*)

CERITHIUM.

A very elongated cone, three times as high as wide. Rather few whorled; whorls flat, more than twice as wide as high. Each whorl is ornamented with three spiral rows of rather small, sharp tubercles, about twelve to fourteen on a whorl in each row. The tubercles are so placed as to form rows nearly perpendicular, or rather parallel to the labial side of the spire. Throughout the shell the spiral rows are at equal distances apart.

CERITHIUM GALLICUM (*D'Orb.*), var.

A greatly elongated cone, three times as high as wide, many- (about 12-) whorled; whorls inflated, with an elevated mesial angle, from which they become smaller anteriorly and posteriorly, towards the sutures; the posterior half of each whorl is flat, but the anterior half is slightly convex. The posterior sutural margin is bordered by an elevated rib, which bears a numerous row of closely-placed tubercles. The part of the whorl between the suture and the suture-like anterior margin of this rib is nearly four times as wide as high; the whorl is one-third as high as wide. A row of sharp, elevated tubercles surmounts the mesial angle of the whorl. The whole spire is finely cancellated, the longitudinal striæ being stronger than those transverse. The base is convex, and separated from the whorl by a slight angular inflation.—(*Woodwardian Museum.*)

This differs from the French form chiefly in the small size and number of tubercles on the mesial angle, and is what some authors would regard as a representative species.

PLEUROTOMA AMPHILOGA (n. sp.).

Shell elongated, 5- or 6-whorled; spire much elevated, two and a half times as high as wide, turreted; whorls elevated, nearly as high as wide, sides parallel with the sutural shoulder rounded. The whorls are ornamented with moderately elevated, narrow, longitudinal ribs, which increase in number, though not in size or closeness, with the growth of the shell. The body-whorl is slightly inflated, and the ribs upon it are wider apart' and relatively less numerous than on the whorl above; they are crossed by numerous' close, spiral striæ. The canal is broken, but the body-whorl could not have been less than twice as long as wide, *i. e.* half the length of the shell.

Although the mouth is not seen, the body-whorl, from which the shell is partly removed, shows beyond doubt the lines of growth characteristic of the genus. The "notch" in the lip appears to extend almost, if not quite, to the suture. It is the only species of the genus possessing the area-railing-like ornament, externally more like a Rostellaria.

FUSUS TRACHYS (n. sp.).

Shell fusiform, rather less than three times as long as wide. Spire elevated, less than half the length of the shell, composed of four or five whorls. Each whorl is twice as wide as high, and banded by two wide, thick, much elevated ribs, the space between which is hollow, and the spaces above and below become constricted and hollow on approaching the whorls they respectively adjoin. The body-whorl, like those preceding it, attains its greatest width at the band of the second rib. Anterior to this are three other ribs, the more anterior two of which are closer together than the others; and anterior to these are several very much smaller and closer together.

The whole shell is marked by close, fine, spiral striæ, which, on the smaller whorls, are often crossed by others in the direction of the axis. The mouth is extremely elongated and very narrow, lips being nearly parallel.

CHEMNITZIA WOODWARDI (n. sp.).

Shell subcylindrical, two and a half times as high as wide, consisting of about seven whorls, which regularly increase in size and are moderately convex. Each whorl is one and three-quarter times as wide as high. The space where the whorls adjoin is concave, and the suture is indistinctly seen. There is no ornament, but a great number of fine, close, spiral striæ.

This and some other shells have quite an Oolitic aspect.

SOLARIUM ORNATISSIMUM (n. sp.).

Depressed, few-whorled, nearly twice as wide as high; composed of about four or five whorls, which somewhat rapidly increase in size, and are five times as wide as high. Marginally the whorl is angular, and on the spiral surface there bordered by a narrow concave groove, which is margined on the inner side by an elevated rib. Above and interiorly there is another hollow space less deep and twice as wide, and near to the suture a row of about fifteen large, expanded, tumid, nearly adjacent tubercles. The base is gently convex and ornamented by close, spiral striæ. The whole of the upper surface is spirally striated, but the striæ are very much finer than those of the base; they are cancellated by equally fine, oblique striæ, which are directed backwards from the suture. The marginal groove of the whorl gives to the spire a marked sutural channel.

This looks very like a Pleurotomaria, but I think it is a Solarium.

PTEROCERAS, representative of FITTONI.

Shell elongated, about half as wide as high.* Spire less than a third the length of the shell, composed of about four whorls. Each whorl is more than a third as high as wide, and has round its middle a sharp, prominent angle; the part of the whorl above this is inclined at an angle of 45°, that anterior to it is perpendicular. The inclined part is banded by five or six striæ, and the upright portion by four or five. In the body-whorl the space posterior to the angle is subconical, for a second angle, which in the smaller whorls is the limit of the upright part, and also the line of suture, is here reduced to a rib. Posterior to this keel are about eight spiral striæ.

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* The specimen, which is broken, is two-thirds as wide as high.

In form this closely resembles *P. marginata* (D'Orb.) and *P. Fittoni* (Forbes).

PLEUROTOMARIA JUKESII (n. sp.).

Few-whorled, subconical, moderately depressed, half as high as wide, consisting of five elevated whorls, which regularly increase in size. The whorls are nearly four times as wide as high, and each twice the diameter of that which preceded it. The filled-in sinus is elevated like a string and situate on the upper part of the whorl, which it divides into an upper and a lower region. The upper is very convex, deeply impressed at the suture, horizontal, and rather narrower than the lower region, which is flat and oblique, being inclined at an angle of about 60°. The slit of the sinus is equal in length to the diameter of the shell. The whole of the upper side is marked with very fine and close spiral ribs.

Under side not seen.

Most nearly related to *P. perspectiva* in form of whorl, but well distinguished by its few whorls.

TROCHUS.

Shell conical, three-fourths as high as wide; composed of about four whorls, which are flat, one-fourth as high as wide, and have the sutures deeply impressed. Each whorl is ornamented with four spiral striæ, of which each supports a row of sharp, elevated tubercles. The tubercles are separated by spaces about as wide as those which divide the rows. The tubercles of the anterior rows are successively placed one between two tubercles of the row above, so that other oblique rows are formed parallel to the labial side of the shell. The base is flat and spirally striate.

TROCHUS.

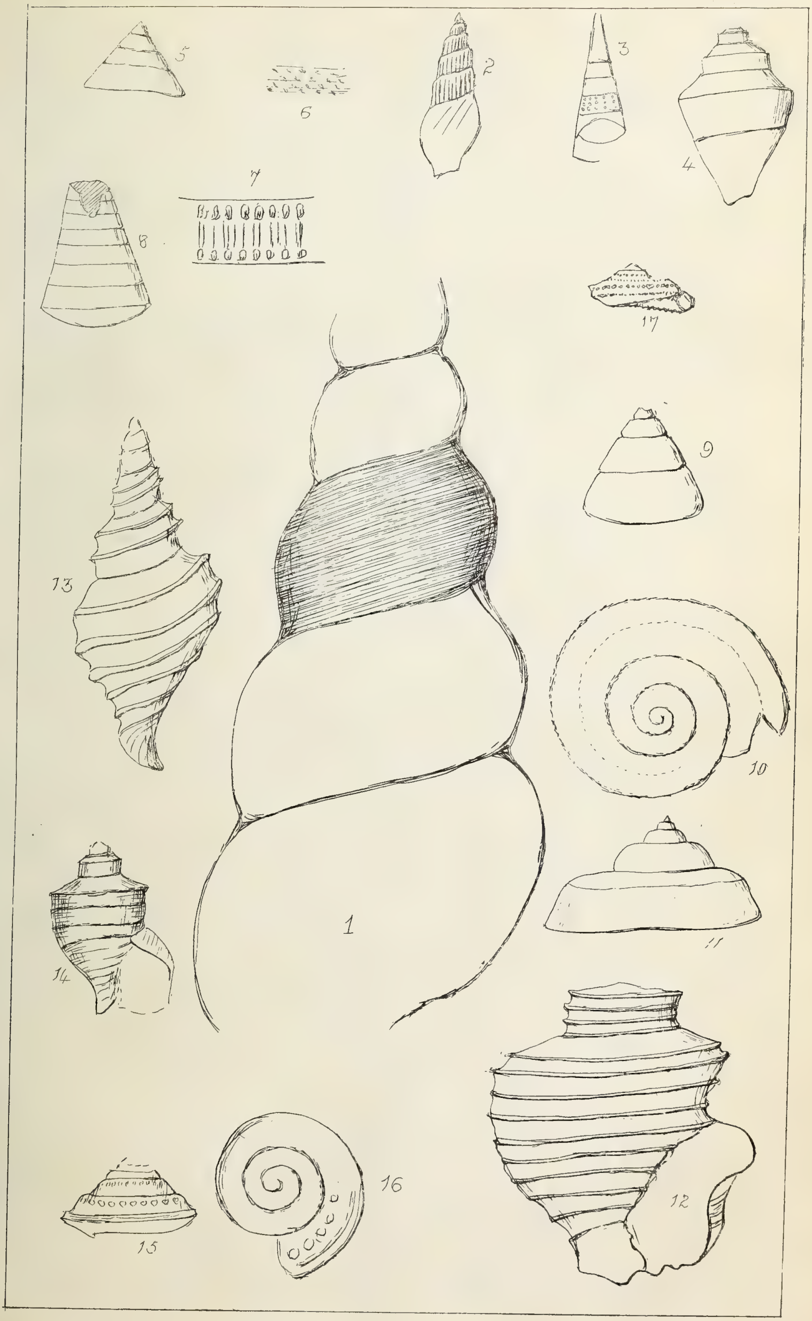
Conical, a little higher than wide, not umbilicated; commonly composed of four or five whorls, which are slightly convex. Each whorl is about two and a half times as wide as high and encircled by about six spiral striæ, which are elevated like cords; the interspaces are much wider than the ribs; they are flat. The highest rib is larger than the others, and in most cases less projecting; it and all the other costæ are crossed by very numerous, oblique, narrow indentations, giving to each rib the look of a twisted rope. The side passes under to the base in a large curve. The base is marked by a greater number of striæ than the side; they are less elevated, rather closer together, and not bead-like. Shell rather thick. The suture is wide and deeply impressed.

Very nearly related to *T. Geinitzii* (Rss.).

(?) FUSUS.

Subangularly fusiform; composed of four or five whorls. Spire nearly half the length of the shell. Whorls angular, rapidly enlarging, twice as wide as high. Ornamented with four sharp, narrow, rather elevated ribs, below which, towards the columella, are a number of fine striæ, rather distant apart. The whorls are so coiled that two (? one) of the four costæ are covered by the body-whorl. The most prominent rib is the most posterior, which projects like a cord. The space between it and the suture is flat and inclined at a small angle, and the space below it, for half the body-whorl, is parallel to the axis. The slope of the ledge of the upper part of the whorl appears to become greater as the shell increases in size. Mouth pear-shaped. The shell is finely striated spirally, there being some twelve lines between two ribs, and these striæ are crossed by still finer

PL. VIII.



FAC-SIMILES OF MR SEELEY'S SKETCHES OF CHALK
GASTEROPODS.

lines of growth. In a young state the shell is longitudinally ribbed, the ribs being tumid and close together; no trace of this is seen in the adult.

A second specimen, probably of the same species, is rather larger, and has a rib between the suture and the marginal angle, and six primary ribs on the body-whorl.

Both these examples are distorted by pressure. The smaller example (figured) is compressed laterally. The rock is a very hard chalk, much resembling some of the lighter-coloured clay concretions; fossils are yellowish.

(?) FUSUS.

This form differs from the Brighton specimens chiefly in the large number of equal-sized ribs, a character to which little importance can be given; it may be varietal, but more probably is but an adult ornament, just as are the longitudinal ribs, a feature peculiar to the young. The lip is a little inflected. The space between the posterior two ribs appears to have supported a sharp projecting keel, now broken away.

SOLARIUM BINGHAMI (*Baily*).

Shell thick, much depressed, not half so high as wide; composed of about six whorls, which very gradually increase in size. The upper side of the shell is a greatly depressed cone; the under side a large conical hollow. The whorls are five-angular; they are attached by one side, two converge inferiorly to form the base, one perpendicular forms the side of the shell, and the fifth forms the slightly oblique upper surface.

This last form of the upper surface of the whorl is ornamented marginally by upwards of forty tubercles, which are elongated in a direction at right angles with the line of growth. A second row, more numerous and much smaller, passes round near to the suture. Both the interspace and tubercles are finely striated spirally. The perpendicular side is not more than half the width of the outer basal space; it has on its lower margin a row of tubercles similar to that on its upper margin, but they are narrower and half as numerous again. The tubercles so entirely occupy the side that the groove between the two rows is not half so wide as either of them. The outer part of the base is very finely cancellated; the angle it makes with the inner half is nodulated with seventeen large tubercles. The inferior suture is much more impressed than the superior one, and the sutural margin of the base is ornamented with a row of tubercles, about as numerous as that on the upper margin of the side. The umbilicus is nearly as deep as wide.

ON THE DENUDATION OF ARTHUR'S SEAT.

BY JAMES HASWELL, M.A.

> "Quid magis est saxo durum? quid mollius unda?
> Dura tamen molli saxa cavantur aqua."

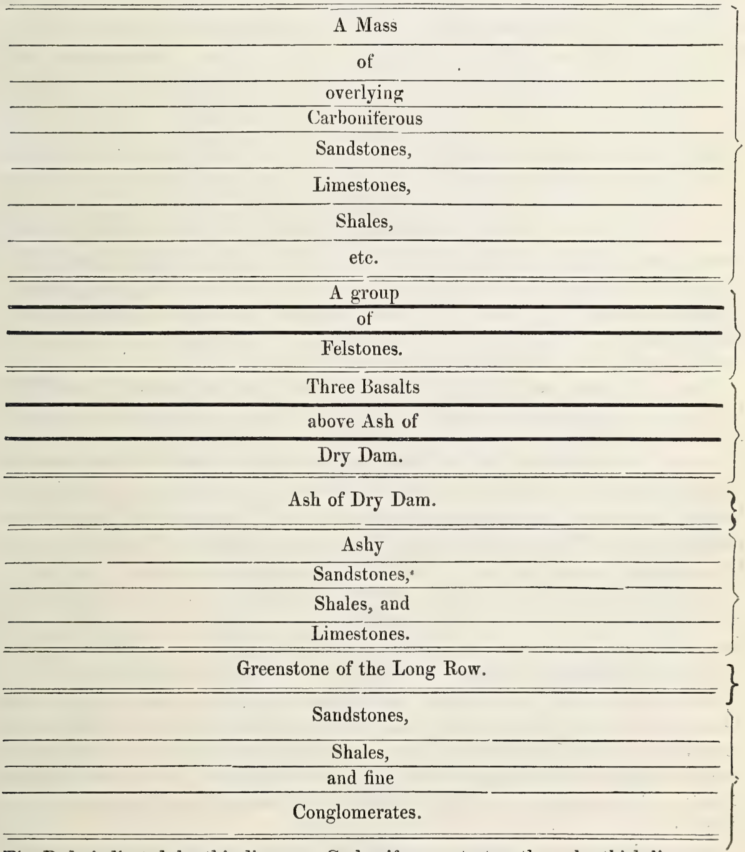
The condition of Central Scotland during the long period represented by the Secondary formations is involved in darkness. On the east and west coasts of Scotland rocks of Secondary age occur north of the Grampians, but of the physical history of *Central* Scotland during the time these rocks were deposited, we know nothing. From the time of the deposition of our Upper Coal-beds, or, it may be, of some Permian Sandstones, up till the time when the whole island was locked fast in one immense mantle of ice, we are almost entirely ignorant of what was going on in that part of the country which lies between the Grampians and the Forth. And the man who shall decipher for us the physical geography of that period, and reveal to us the old surface of that district, with its vegetation and animal productions, prior to the time of the Boulder Clay, will have rendered no small service to the cause of Scottish geology.

But although we have not as yet been able to trace the old surface of the land, we are not altogether without data to guide us in our researches. One thing is clear and certain,—a great change was taking place over the whole face of this region.

Both during and after the deposition of the coal-measures, great volcanic agencies were at work. In the neighbourhood of Edinburgh they were particularly active. They had been so during the Old Red Sandstone period, and contributed in no small degree to the formation of the Pentland Hills. But towards the close of the Old Red period and the commencement of that time when our Lower Carboniferous Sandstones were being formed, the Pentland ridge began to sink under those Carboniferous seas. The crater of eruption, which had been so active in the Pentland area, and produced that varied mass of material now presented to us as sheets of felstone and ashy bands, became gradually quiescent, till at last it was entirely covered over with the increasing deposits. But, while these deposits were being accumulated, the igneous forces broke out again at Arthur's Seat. Most of the rocks which now form the eastern part of the hill belong to this period. The greenstone of the Long Row, the red nodular ash and the thin bands of red ashy sandstone to be seen in a section at the south side of the Queen's Drive, the green felspathic ash of the Dry Dam, the black columnar basalt above it (which also constitutes the crag on which stands St. Anthony's Chapel), the two basalts behind St. Anthony's, and which form the *lower* part of Dunsapie Hill and Calton Hill, and lastly, that group of felstones which form the remainder of the eastern part of the hill from the *top* of Dunsapie across Whinny Hill to St. Margaret's Station, and which make up most of the Calton Hill,—all these igneous productions were *contemporaneous* with the Lower Carboniferous strata, and are found *interbedded* with them. Consequently, all these traps are *subaqueous*. Layers of sediment were first formed, then an eruption of lava took place, which spread itself in sheets over the strata; then more layers of mud and sand were deposited by the ocean, and then more sheets of lava ejected by the igneous agency below. It is evident, moreover, that these traps must have been more or less horizontal, for if they had been poured over an *inclined* surface, they would have collected in masses at the foot of the declivity,—a state in which we do not now find them.

THE LOWER CARBONIFEROUS STRATA AND INTERBEDDED TRAPS OF ARTHUR'S SEAT, IN THEIR ORIGINAL POSITION.

Fig. 1.



The Beds indicated by thin lines are Carboniferous strata; those by thick lines are Interbedded Traps.

In this way the elevating processes continued their unceasing work, stratum after stratum was deposited, sheet after sheet of lava ejected and consolidated, until, when the last of the porphyritic felstones had been produced, the igneous centre gave signs of cooling, and all became comparatively quiet. Then the sediment of these Lower Carboniferous seas accumulated over the solidified lavas, ganoid fishes revelled undisturbed in the Burdiehouse Estuary, and plants peculiar to the period were entombed in the mud; while, as the result of all, after many ages had elapsed and hundreds of years had passed away, an immense series of strata was elaborated, which extended continuously over the site of the Pentlands. The same waters under which was laid down the ash of the Dry Dam, and which held in solution the substances which fill the amygdaloidal cavities of the greenstones and felstones above it, also deposited above these rocks an enormous series of beds, 3000 ft. thick at least, of sandstone, shale, and limestone, the edges of which are seen on the beach eastwards from Portobello, and at East Cairn Hill on the Pentlands, at a height of 1839 ft. above the level of the sea, *i. e.* 1000 ft. above Arthur's Seat. These rocks also extend northwards into Fife. This is represented in the accompanying diagram.

It is perfectly evident then, from what has been already said, that Lower Carboniferous strata must have been elaborated far above the present altitude of Arthur's Seat, and that their area extended for a considerable distance on all sides, overlying the whole ridge of the Pentlands. It is also pretty clear, both from the horizontal beds of sandstone on the summit of East Cairn Hill, and from the state of the case generally, that these strata were at first laid down in a horizontal position, or at all events very nearly so.

Now, the *next* stage through which these rocks passed is easily determined. An *upheaving* movement must have taken place, by which the whole beds of the hill, already alluded to as forming the eastern part, on to the centre of the Musselburgh basin, were raised into the *inclined* position in which we *now* find them. If evidence of this upheaval is wanted, we have only to point to St. Leonard's Craig, Salisbury Craigs, with the two dykes cutting through them, and the Dasses, the only intrusive traps of the hill, and all found on the *western* side. The effects of this upheaval are well displayed at Salisbury Craigs, where the beds have an easterly dip, being raised on the west and depressed on the east, and where both the sandstone and the greenstone are altered in colour and texture at the point of contact. Indeed, nothing shows the intrusive character of this trap more clearly than the seam of shale to be seen at the south end of the Craigs, very much hardened and broken, lying completely enveloped in the greenstone. After this eruption, then, the rocks of the hill would present somewhat the appearance given in the accompanying diagram, Pl. V. Fig. 1.

But this is not the present aspect of the hill; Carboniferous strata no longer conceal the trap-rocks from view. How, then, have they disappeared? What has become of them? The answer is, *denudation* must have taken place. Now I think it is a fact which can be easily demonstrated, that Arthur's Seat has been subjected to denudation at *two* different periods.

First Period.—After the upheaving of the strata, already referred to, the beds, of course, were set on their edges (as in preceding figure), and were much fractured. The faults, too, which are so abundantly met with in the coal-measures, were no doubt produced by this upheaval. Consequently, in this state, the strata were more easily exposed to the action of tides and oceanic currents. The upper part of the hill, consisting of softer strata than the traps beneath, would soon be swept away and the waste material deposited in some other place; while the lower part of the hill, the traps themselves, owing to their hardness and tenacity, would resist the action of the waves more, and so stand out in bold relief above the softer Carboniferous strata. This is represented in the accompanying diagram; in fact, this is exactly the appearance which a section through the north end of Arthur's Seat would present, if the rocks round the summit were taken away (Pl. V. Fig. 2). We shall have occasion to refer to these rocks presently; but it is now well known that the volcanic ash or trap-tuff round the summit, the basalt of the summit itself, the columnar basalt of the Lion's Haunch, and the porphyritic felstone which forms part of the ridge descending from the summit into the south end of the Dry Dam, are each and all of them of a more recent age than the other traps of the hill.

Now if it can be shown that these *later* igneous rocks cover over and rest upon the *denuded* edges of the *older* traps and the Carboniferous strata, what other conclusion is open to us but the one already alluded to, viz. that after a great mass of Carboniferous strata had been deposited on the top of the interbedded traps, and after these had been tilted up into their present position by the eruption of St. Leonard's Craig, Salisbury Craigs, and the Dasses,—the whole of these rocks, being still under water, were subjected to marine denudation, and the waves, tides, and currents aided by the atmosphere, the springs, and the frosts, and performing their functions exactly in the same way as we see them now, gradually swept away the softer material, and left the harder traps as prominent crags? We find the later ash filling up the valley between the Long Row and the Dasses, and hanging down into the Hunter's Bog, which it must have once filled, as it could not stop short there; consequently these *valleys must* have been *eroded* before the ejection of the ash. This tells its own history. Moreover we find the same ash covering over the Long Row, the Dasses, and the greenstone seen in a section at the south side of the Drive (which is a continuation of the Long Row), and all these must have existed as *prominent crags* when the ash and the scoriæ fell around them. In the bed of the Firth of Forth also, many traps project from the coal strata which are known to form its channel,—Inch-Garvey, Inch-Colm, Cramond Island, Inch-Keith, Fidra, Craigleith, and the Bass Rock.

The denudation we speak of was not confined to Arthur's Seat alone. It extended over a larger area. The Pentland Hills which lay submerged under the same sea also suffered from it, the Roman Camp Hill also, and indeed the whole surrounding area of the Lothians. It has been calculated that the Carboniferous strata which covered the Pentlands and Arthur's Seat amounted in thickness to 8000 feet, but supposing they were only 5000 feet thick, this, with the present average height of the Pentlands, at 1000 feet above the surrounding country, would give us as the amount of material removed, a quantity corresponding to *five* times the existing mass of the Pentlands, and as these hills are 14 miles long by 3 broad, that mass must have been equal to 42 cubic miles.

This great denudation must evidently have required a long lapse of ages for its completion. While Permian and Secondary rocks were being deposited in other parts of the island, as, for instance, Oolitic rocks on the east and west coasts of Scotland, north of the Grampians, and Permian and Trias in the south, the central part of Scotland was undergoing a great change. No strata apparently were being elaborated, many however were being swept away; the work of abrasion and demolition was everywhere dominant. The softer strata of sandstone, shale, and limestone were carried off, and the numerous trap-rocks of the district left standing out in high relief, till in short the country began to assume very nearly its *present* appearance. The first period of denudation then is ended, and another period of volcanic activity is at hand.

Second Period.—Midlothian, still under water, is subjected to the ravages of a submarine volcano. The Tertiary period has come, and the igneous forces round Edinburgh, so long quiescent, so many millions of years at rest, which had not disturbed the neighbourhood since the Lower Carboniferous age, again become vigorous, again break out on the site of the old volcano. One can almost fancy the scene. The sky begins to lour, a rumbling noise is heard, and the crater of Arthur's Seat sends forth from its mouth showers of scoriæ and volcanic ash. As it fell over the truncated edges of the older rocks of the hill, large fragments of the sandstones, greenstones, basalts, porphyries, and amygdaloids were embedded in the felspathic paste, and soon converted into conglomerate when cooled. Then the crater of the summit was plugged up with solid basalt, and the volcanic material not being able to find a vent, burst out through a lateral orifice and formed what is now the Lion's Haunch. Last of all, another ejection of lava took place and wrapping round the north-east end of the basalt gave rise to the felstone of this part of the hill, and closed for ever the eruptions of Arthur's Seat (Pl. V. Fig. 3).

The hill however does not present the same appearance to-day that it did then. The ash must have fallen thickly over the site of Edinburgh, as is evident from the *fragmental* condition of the cliff of ash above Hunter's Bog, and also of the basalt on the slope at the south side of the hill, which never could have stopped abruptly there. Consequently we are led to conclude that Midlothian has been subjected to *another* process of denudation, subsequent to the ejection of these rocks. What was the nature of *this* denudation? It cannot have been due to atmospheric causes, nor to the action of the waves of the sea. Its true cause must be sought for in the *Glacial period*, when another change of contour was effected on Arthur's Seat. The greenstones and basalts were ground down and polished by the friction of the moving ice, the loose ash was swept away, and only that part of it left which had been more firmly compacted round the heated orifice of the summit (Pl. V. Fig. 4).

Fig. 1.

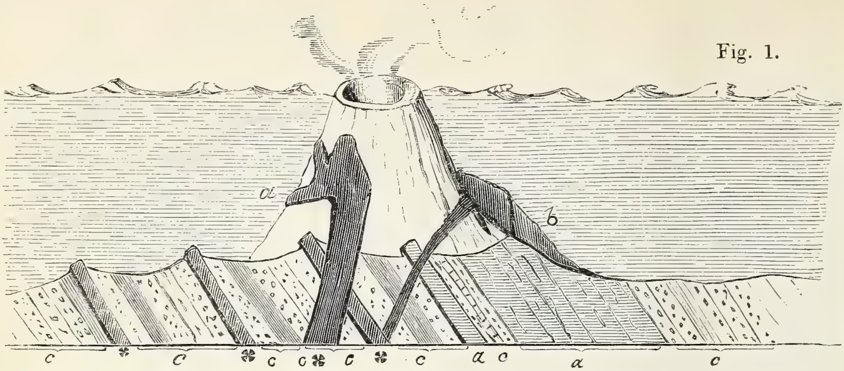


Fig. 2.

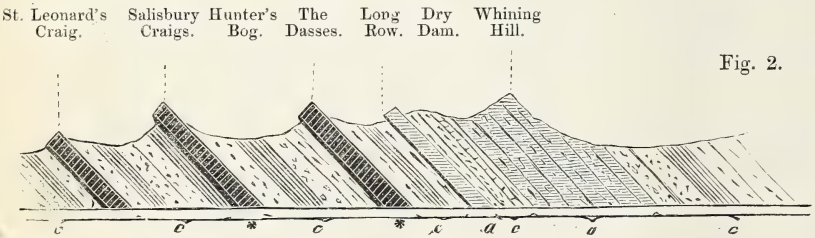


Fig. 3.

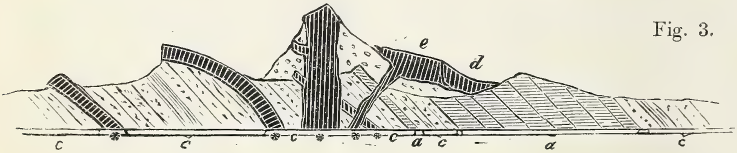
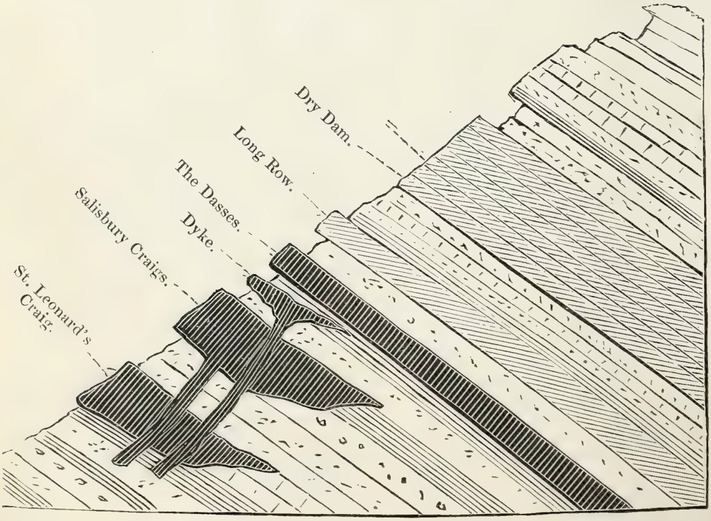


Fig. 4.



DENUDATION OF ARTHUR'S SEAT.

I need not now allude to the evidence we have for *glacial* action on Arthur's Seat. The groovings and markings above Sampson's Ribs and elsewhere, the number of greenstone and sandstone boulders scattered up and down in various parts of the hill, the "crag and tail" contour of the hill, and the character of the drift accumulated on the east side, are all familiar to the Edinburgh student of geology, and point to a time when, after remaining for a long period locked in ice, Arthur's Seat sank far below the sea-level, and when ice-borne blocks from the Highlands were dropt on the slopes of the Pentlands.

Explanation of Plate.

Fig. 1. The Lower Carboniferous strata and interbedded traps of Arthur's Seat upheaved by the intrusive traps.

Fig. 2. The Lower Carboniferous strata and older traps of Arthur's Seat of the marine denudation.

Fig. 3. Submarine volcanic cone during the Tertiary (?) epoch, ejecting ash-scoriæ, etc., and producing the later Igneous rocks of Arthur's Seat. The cone of coarse volcanic ash and conglomerate. *a*. Basalt of summit; *b*. Basalt and Felstone of Lion's Haunch.

Fig. 4. Present appearance of Arthur's Seat after glacial action.

a Volcanic Ash, Trap, etc. * Trap, etc. *c* Carboniferous strata.

A LIST OF TYPICAL AND OTHER FIGURED SPECIMENS OF FOSSIL VERTEBRATA IN THE BRITISH MUSEUM.

(This list does not profess to give the title of every work in which the figures are reproduced or copied, but only of those in which they first appeared, or of such as may be used for general reference.)

I. MAMMALIA.

Human Skeleton.—*Post-Tertiary*, Guadaloupe.—Phil. Trans. 1814, p. 107, pl. 3.

Palæospalax magnus (lower jaw).—*Pleistocene, Freshwater*, Bacton, Norfolk.—Owen, Brit. Foss. Mam. 1846, p. 25, f. 12.

Canis (Vulpes) vulgaris, Brisson.—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. p. 134, f. 51, 53.

Galecynus Œningensis, Owen.—Quart. Journ. Geol. Soc. 1846, vol. iii. p. 55, f. 1, 3, 5; (*Canis Vulpes*, Murch. and Mant.), Trans. Geol. Soc. 1830, vol. iii. p. 277, pl. 33, 34, f. 1–3; (*Canis palustris*), Mey., Fauna der Vorwelt, Oeningen, 1845, p. 4, pl. 1.

Mustela (Plesictes) Croizeti, Pomel (lower jaw).—*Miocene*, St. Gerand-le-Puy.—Bull. Soc. Géol. Franc. 1847, tome iv. ser. 2, p. 385, pl. 4, f. 4.

—— *(Plesiogale) angustifrons*, Pomel. — *Miocene*, St. Gérand-le-Puy. — Bull. Soc. Géol. Franc. 1847, tome iv. ser. 2, p. 385, pl. 4, f. 3; Pictet, Paléontologie, 2nd edit. 1853–7, pl. 4, f. 7.

Putorius ermineus, Linn.—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. p. 116, f. 40–42.

Hyæna spelæa, Goldfuss (lower jaw).—*Cavern*, Gailenreuth.—Cuvier, Oss. Foss. edit. 1836, pl. 192, f. 9.

—— *spelæa* (diseased skull).—*Cavern*, Muggendorf.—Owen, Brit. Foss. Mam. p. 154, f. 59.

Hyæna spelæa (part of lower jaw).—*Pleistocene*, Walton, Essex.—*Ibid.* p. 151, f. 58.

Felis Issiodorensis, Croizet and Jobert.—*Pliocene*, Mt. Perrier.—Oss. Foss. du Puy-de-Dôme, 1828, pl. 4, f. 4.

Felis pardinensis, Croizet and Jobert.—*Pliocene*, Mt. Perrier.—Oss. Foss. du Puy-de-Dôme, 1827, pl. 7, f. 2.

Felis brevirostris, Croizet and Jobert.—*Pliocene*, Mt. Perrier.—Oss. Foss. du Puy-de-Dôme, 1828, pl. 6, f. 6, 9.

Felis spelæa, Goldfuss (portion of upper jaw).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. p. 161, f. 63.

Ursus spelæa (lower jaw).—*Pliocene*, Bacton, Norfolk.—Owen, Brit. Foss. Mam. p. 106, f. 35 *c*.

Meles Taxus, Linnæus.—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. p. 109, f. 37.

Arvicola amphibia, Linn. (upper and lower jaw).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. 1846, p. 201. f, 76.

—— *pratensis*, Owen (upper and lower jaw).—*Cavern*, Kent's Hole, Torquay.—Brit. Foss. Mam. 1846, p. 208, f. 78.

—— *agrestis*, Flem. (lower jaw and leg-bone).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. 1846, p. 206, f. 77.

Trogonotherium Cuvieri, Fischer (lower jaw).—*Pleistocene*, *Freshwater*, Bacton, Norfolk.—Owen, Brit. Foss. Mam. 1846, p. 184, f. 71; Mantell, Petrifactions, p. 358, f. 74.

Lepus timidus, Linn. (lower jaw).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. 1846, p. 210, f. 80.

—— *cuniculus*, Linn. (lower jaw).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss. Mam. 1846, p. 212, f. 81.

Lagomys spelæus, Owen (fore part of skull).—*Cavern*, Kent's Hole, Torquay.—Owen, Brit. Foss, Mam. 1846, p. 213, f. 82, 84.

—— *Meyeri*, Von Tschudi.—*Pliocene*, Oeningen.—(*Anœma Œningensis*), König, Icones Foss. Sect. 1825, pl. 10, f. 126.

Carterodon sulcidens, Lund, sp. (cranium).—*Cavern*, Brazil.—Waterhouse, Nat. Hist. Mam., vol. i. p. 351, pl. 16, f. 7.

Glyptodon tuberculatus, Owen (tail sheath).—*Pleistocene*, Buenos Ayres.—Mantell, Petrifactions, 1851, p. 359, f. 75.

Megatherium

Mastodon Ohioticus, Blumenb. (lower jaw).—*Pleistocene*, North America.—Phil. Trans. 1768, pl. 4, f. 1; Falc. and Cautl., Fauna Ant. Sivalenis, pl. 3, f. 9; pl. 35, f. 4, 5; pl. 40, f. 16.

—— *angustidens*, Cuv.—? unknown.—Falc. and Cautl. Fauna Ant. Siv. pl. 40, f. 7.

—— *latidens*, Clift.—*Miocene*, Ava.—Falc. and Cautl. Fauna Ant. Siv. pl. 31, f. 1, 3, 4, 6–8; pl. 40, f. 1–3.

—— *Andium*, Cuv.—*Pliocene*, Buenos Ayres.—Falc. and Cautl. Fauna Ant. Siv. pl. 35, f. 3; pl. 40, f. 10–14.

—— *Perimensis*, Falc. and Cautl.—*Miocene*, Perim Island.—Fauna Ant. Siv. pl. 31, f. 9, 10; pl. 38, 39, f. 1–3; pl. 40, f. 4.

—— *Arvernensis*, Croiz. and Job.—*Miocene*, Eppelsheim.—Falc. and Cautl. Fauna Ant. Siv. pl. 36, f. 11; pl. 40, f. 6.

—— *Arvernensis*, Croiz. and Job. (upper molar).—*Mammaliferous Crag*, Whitlingham, Norfolk.—Smith, Strata Identified, 1816, frontispiece; Owen, Brit. Foss. Mam. p. 276, f. 97; Falc. and Cautl. Fauna Ant. Siv. pl. 36, f. 8.

—— *Sivalensis*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 3, f. 10; pl. 18A, f. 6; pl. 32, 33, 34, f. 2, 3; pl. 35, f. 1; pl. 36, f. 2, 5; pl. 37, f. 1–4, 6, 7; pl. 39, f. 4–6.

Elephas Cliftii, Falc. and Cautl.—*Miocene*, Perim Island.—Fauna Ant. Siv. pl. 30, f. 5.

—— *bombifrons*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 25, f. 2, 3; pl. 26–28, 29, f. 1, 2, 4, 6; pl. 29A, f. 1–5, 7; pl. 29B, f. 6, 7.

Elephas Ganesa, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 3, f. 7; pl. 21, 22, 22 A, f. 1, 2; pl. 24, f. 3–5; pl. 24 A, f. 1; 25, f. 1; pl. 25 A, f. 1, 2, 4, 5, 7.

—— *insignis*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 2, f. 6; pl. 15, 17, 18, f. 1–6; pl. 18 A, f. 3, 5; pl. 19, f. 1–6, 8; pl. 19 A, 20 A, f. 4, 7; pl. 24 A, f. 2; pl. 25, f. 4; pl. 29 B, f. 8.

—— *insignis*, Falc. and Cautl.—*Pliocene ?*, Central India.—Fauna Ant. Siv. pl. 56, f. 10, 11.

—— *insignis ?*, Falc. and Cautl.—*Pliocene ?*, Central India.—Fauna Ant. Siv. pl. 56, f. 12–14.

—— *planifrons*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 2, f. 5; pl. 6, f. 5–6; pl. 8, f. 2; pl. 9, 10, 11, f. 2–10; pl. 12, f. 2, 5, 7, 8, 11–13; pl. 14, f. 8, 9; pl. 18, 18 A, f. 1, 2.

—— *meridionalis*, Nesti.—Dredged off Happisburgh.—Falc. and Cautl. Fauna Ant. Siv. pl. 14 B, f. 13.

—— *meridionalis*, Nesti.—*U. Tertiary*, Val d'Arno, Tuscany.—Falc. and Cautl. Fauna Ant. Siv. pl. 14 B, f. 10.

Elephas priscus, Goldfuss.—*Unknown.*—Falc. and Cautl. Fauna Ant. Siv. pl. 14, f. 6, 7.

—— *Hysudricus*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. , f. 3; pl. 4, 5, 6, f. 1–3; pl. 7, f. 1–8, 12; pl. 8, f. 3, 5; pl. 13 A, 13 B, f. 7; pl. 14, f. 10.

—— *Hysudricus*, Falc. and Cautl.—*Pliocene*, Central India.—Fauna Ant. Siv. pl. 12 C, f. 6.

—— *antiquus*, Falc.—*Pliocene ?*, Gray's Thurrock, and other British localities.—Fauna Ant. Siv. pl. 12 D, f. 4; pl. 13 A, f. 5; pl. 14, f. 1, 2; pl. 14 A, f. 3, 5, 8, 10, 12, 13.

—— *antiquus*, Falc.—*Pliocene*, Via Appia, Rome.—Fauna Ant. Siv. pl. 14 A, f. 13.

—— *Namadicus*, Falc. and Cautl.—*Pliocene*, Central India.—Fauna Ant. Siv. pl. 13, 12 A, 12 B, 12 C, f. 1–5; pl. 12 D, f. 1–3; pl. 24 A, f. 4; pl. 48, f. 1; pl. 56, f. 1–4.

—— *Columbi*, Falc. }
—— *Texianus*, Blake } —*Pleistocene*, Texas.—Geologist, Vol. V. p. 57, pl. 4.

—— *Armeniacus*, Falc.—*Pleistocene ?*, Armenia.—Nat. Hist. Rev. 1863, p. 73, pl. 2, f. 2.

—— *primigenius*, Blum.—*Pleistocene*, Eschscholtz Bay.—Beechey, Voy. of the 'Beagle,' 1831, vol. ii. p. 593, pl. 1, 2.

—— *primigenius*, Blum.—*Pleistocene*, Bacton, Norfolk.—Falc. and Cautl. Fauna Ant. Siv. pl. 1, f. 1.

—— *primigenius*, Blum. (lower jaw).—*Pleistocene*, Worms, Hesse Darmstadt.—Falc. and Cautl. Fauna Ant. Siv. pl. 13 A, f. 2.

—— *primigenius*, Blum.—Unknown.—Falc. and Cautl. Fauna Ant. Siv. pl. 13 A, f. 3.

—— *primigenius*, Blum.—*Pleistocene*, Yarmouth, Norfolk.—Owen, Brit. Foss. Mam. 1846, p. 221, f. 86.

Vertebræ, bones of the extremities, etc., of *Proboscidia.*—*Miocene*, India.—Falc. and Cautl. Fauna Ant. Siv. pl. 46–55.

Dinotherium Indicum, Falc.—*Miocene*, Perim Island.—Journ. Geol. Soc. 1845, vol. i. p. 360; Fauna Ant. Siv. pl. 36, f. 6.

Rhinoceros Sivalensis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 73, f. 3; pl. 74, f. 5, 6; pl. 75, f. 5, 6.

—— *palæindicus*, Falc. and Cault.—*Miocene*, Sewalik Hills.—Fauna Ant. Siv. pl. 74, f. 1, 3, 4; pl. 75, f. 2–4.

—— *platyrhinus*, Falc. and Cautl.—*Miocene*, Sewalik Hills.—Fauna Ant. Siv. pl. 71, f. 1, 3, 6, 7; pl. 72, f. 1, 2; pl. 75, f. 9–12.

—— *Perimensis*, Falc. and Cautl.—*Miocene*, Perim Island.—Fauna Ant. Siv. pl. 76, f. 15 and 16.

—— *tichorhinus*, Cuvier.—*Pleistocene*, Chartham, Kent.—Owen, Brit. Foss. Mam. f. 125, 127; Somner's Chartham News, 1669.

Rhinoceros tichorhinus, Cuvier (upper molar).—*Cavern*, Kirkdale.—Owen, Brit. Foss. Mam. p. 335, f. 125.

—— *tichorhinus*, Cuvier (lower molar).—*Pleistocene*, Regent's Canal, London.—*Op. cit.* p. 337, f. 127.

—— *leptorhinus*, Cuvier.—*Pliocene*, Walton and Clacton, Essex.—*Op. cit.* p. 356, f. 129, 131–135, 138–141.

Lophiodon or *Palæotherium* (phalanx).—*Eocene*, Isle of Wight.—Owen, Brit. Foss. Mam. p. 309, f. 106.

Paloplotherium annectens, Owen (cranium and lower jaw).—*M. Eocene*, Hordwell, Hants.—Quart. Journ. Geol. Soc. 1848, vol. iv. pl. 3, f. 1–3.

Hippotherium Antelopinum, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna, Siv. pl. 82, f. 13–17; pl. 84, f. 5–7, 9–12; pl. 85, f. 9–16, 18.

Equus Sivalensis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna, Ant. Siv. pl. 81, f. 1–4; pl. 82, f. 1–3, 5, 6; pl. 84, f. 1–4; pl. 85, f. 1, 3, 5, 6, 8.

—— *Namadicus*, Falc. and Cautl.—*Miocene*, *Pliocene*, Sewalik Hills?, Nerbudda.—Fauna, Ant. Siv. pl. 81, f. 5–7; pl. 82, f. 7, 8.

—— *palæonus*, Falc. and Cautl.—*Pliocene*, Nerbudda.—Fauna Ant. Siv. pl. 82, f. 9–11.

—— sp.—*Pliocene?*, from the Irawaddi.—Fauna, Ant. Siv. pl. 82, f. 12.

—— sp.—*Pliocene*, Nerbudda, Nelee Pass.—Fauna, Ant. Siv. pl. 84, f. 13, 14; pl. 84, f. 15, 17–19.

Coryphodon eocænus, Owen.—*Eocene*, Essex coast.—Brit. Foss. Mam. p. 299, f. 103; f. 4, 107.

Tapirus priscus, Kaup.—*Red Crag*, Woodbridge, Suffolk.—Owen, Journ. Geol. Soc. 1856, vol. xii. p. 233, f. 9.

Nesodon ovinus, Owen.—*Pleistocene*, S. W. coast of Patagonia.—Phil. Trans. 1853, p. 291, pl. 15, 16.

Hippopotamus (Hexaprotodon) Sivalensis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 60, f. 1–3; pl. 61, f. 1, 2, 4–11; pl. 62, f. 2–8, 10; pl. 63–66.

—— *(Hexaprotodon) Iravaticus*, Falc. and Cautl.—*Pliocene?*, Irawaddi River, Central India.—Fauna, Ant. Siv. pl. 57, f. 10.

—— *(Hexaprotodon) Namadicus*, Falc. and Cautl.—*Pliocene*, Nerbudda River, Central India.—Fauna, Ant. Siv. pl. 58, f. 1-3.

—— *(Tetraprotodon) palæindicus*, Falc. and Cautl.—*Pliocene*, Nerbudda River, Central India.—Fauna Ant. Siv. pl. 57, f. 1–4, 6–9; pl. 58, f. 4–10; pl. 62, f. 11, 12.

Hyopotamus Vectianus, Owen.—*Eocene*, Isle of Wight.—Quart. Journ. Geol. Soc. vol. iv. p. 102, pl. 8, f. 1–5.

Sus (Hippohyus) Sivalensis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 70, f. 1; pl. 71, f. 1–4.

—— *giganteus*, Falc. and Cautl.—*Miocene*, *Pliocene*, Sewalik Hills, Nerbudda River.—Fauna Ant. Siv. pl. 69, f. 1, 3; pl. 70, f. 4–7; pl. 71, f. 12, 15–19; pl. 72, f. 8.

—— *Hysudricus*, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 70, f. 2, 3; pl. 71, f. 5–11.

Microchærus erinaceus, Wood.—*M. Eocene*, Hordwell, Hants.—Charlesworth, Geol. Journ. pl. 2, f. 1.

Chalicotherium Sivalense, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 80, f. 2–4.

Dicobane ovina, Owen (lower jaw).—*U. Eocene*, Isle of Wight.—Quart. Journ. Geol. Soc. 1857, vol. xiii. p. 25, pl. 8.

Cainotherium commune, Brav.—*Miocene*, Allier, France.—Blainv. Ostéog. pl. 7, Pachyderma.

Merycopotamus dissimilis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Fauna Ant. Siv. pl. 62, f. 15–18; pl. 67, f. 1–8; pl. 68, f. 1, 3–8, 11–15, 17, 18.

Didymodon Vauclusianum, Blake (portion of lower jaw).—*Eocene*, Vaucluse.—Geologist, 1863, Vol. XI. p. 8, pl. 2.

Cervus tarandus, Linn. (cranium).—*Cavern*, Berry Head, Devon.—Owen, Brit. Foss. Mam. p. 481, f. 198.

Camelus Sivalensis, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Asiatic Researches, 1836, vol. xix. p. 120, pl. 20, f. 3, 4, 6; pl. 21, f. 8, 11–13; Fauna Ant. Siv. pl. 86, f. 2–5; pl. 87, f. 1–11; pl. 88, f. 1–6; pl. 89, f. 1–14; pl. 90, f. 1–15.

Sivatherium giganteum, Falc. and Cautl.—*Miocene*, Sewalik Hills, India.—Asiatic Researches, 1835, vol. xix. p. 1, pl. 1; Fauna Ant. Siv. pl. 91–2.

Bison priscus, Bojanus (cranium).—*Pleistocene*, Eschscholtz Bay.—Beechey, Voy. of 'Beagle,' 1831, vol. ii. p. 593, pl. 3.

—— *priscus*, Bojanus (metatarsal).—*Pleistocene*, Clacton, Essex.—Owen, Brit. Foss. Mam. p. 497, f. 207.

Bos frontosus, Nielson (cranium).—*Pleistocene*, Bawdsey Bog, Suffolk.—Mackie, Geologist, 1862, Vol. V. pl. 15.

—— *primigenius*, Bojanus (cranium).—*Pleistocene*, Atholl, Perthshire.—Owen, Brit. Foss. Mam. p. 498, f. 208, 209.

Bubalus moschatus, Owen (cranium).—*Pleistocene*, Maidenhead.—Quart. Journ. Geol. Soc. 1856, vol. xii. p. 127, f. 1–3.

Balænodon physaloides, Owen.—*Red Crag*, Felixstow.—Brit. Foss. Mam. p. 536, f. 219, 226, 227.

Phascolotherium Bucklandi, Brod. sp. (lower jaw).—*Great Oolite*, Stonesfield.—Owen, Trans. Geol. Soc. vol. vi. p. 58, pl. 6, f. 2; Foss. Mam. p. 61, f. 20; *Didelphys*, Zool. Journ. vol. iii. p. 408, pl. 11; Buckland, Bridgw. Treat. pl. 2, f. A.

Thylacoleo carnifex, Owen.—Phil. Trans. 1859, pl. 11, f. 1; pl. 13, f. 1, 6–8; Owen, Palæontology, 2nd edit. 1861, p. 432, f. 173.

Diprotodon Australis, Owen.—*Pleistocene ?*, Australia.—Palæontology, 2nd edit. 1861, p. 430, f. 171.

Nototherium Mitchelii, Owen.—*Pleistocene ?*, Australia.—Quart. Journ. Geol. Soc. 1859, vol. xv. p. 176, pl. 9, f. 1, 2, 4, 5.

II. BIRDS.

Halcyornis toliapicus, König, sp.—*Eocene*, Sheppey.—Owen, Brit. Foss. Mam. and Birds, p. 554, f. 234, 235; *Larus*, König, Icones Foss. Sect. 1825, f. 193.

Archæopteryx macrura, Owen.—*Lithographic stone* (*U. Oolite*), Solenhofen, Bavaria.—Phil. Trans. 1863, p. 33, pl. 1, 3, f. 1; pl. 4, f. 1, 7, 8; Woodward, Intellectual Observer, 1862, vol. ii. p. 313; Mackie, Geologist, 1863, Vol. VI. p. 1, pl. 1.

Dinornis giganteus, Owen.—*Modern deposits*, Middle Island, New Zealand.—Trans. Zool. Soc. 1856, vol. iv. p. 159, pl. 47, f. 2, 3; Paléontologie, p. 330, f. 111.

—— *elephantopus*, Owen (entire skeleton).—*Modern deposits*, Middle Island, New Zealand.—Trans. Zool. Soc. 1856, vol. iv. p. 149, pl. 43–47, f. 1; Paléontologie, p. 330, f. 111.

Eggs of Birds.—*Paludinen Kalk* (*U. Eocene ?*), Wissenau, near Mayence.—Leonhard and Bronn, Jahrbuch, 1849, p. 69, pl. 3.

CORRESPONDENCE.

Ancient Climates.

Dear Sir,—The readers of the 'Geologist' must, I believe, have all been as gratified by the perusal of the late articles from your hand as I have been myself, suggesting, as they do, ideas out of the beaten track. Indeed' from the editorial remarks which have appeared in several of the recent numbers, I perceive that to turn aside from the footprints of the *Schools*, and to tread in the stranger paths that point towards discovery, is an idiosyncrasy of your mind.

But my object in addressing you is not to point out that which must be patent to all your readers, but rather to offer some remarks on the ideas which the articles referred to express. My remarks are principally made with reference to the note on "Ancient Climates."

Before I come to a consideration of your own more immediate views upon the subject, as contained in the latter part of the paper, perhaps I should explain my opinions as regards what you rightly term one of the enigmas of geology—the maintenance on the earth's surface of a high temperature.

Let us for a moment carry ourselves back in imagination to those early stages of the earth's existence to which science is unable to assign even a probable date, and endeavour to appreciate, in the mind's eye, some of the conditions under which it laboured, when, glowing hot, it was first projected from the anvil of nature into those regions of the illimitable which were destined to be the scene of its career. I say glowing hot, because, although you imply that there is some reason to doubt its ever having suffered any great degree of heat, I for one have never entertained any opinion but that such was its state at one period.

From the burning, seething mass arises a dark and dense atmosphere, of which carbon and carbonic acid formed the great ingredients, presenting as effectual a screen against the entrance of the sun's rays as it did to the escape of heat from the body of the planet it surrounded. Though the sun occupied its place as the centre, its attributes—light and heat—as far at least as our planet was concerned, were not experienced, "and darkness was upon the face of the deep."

Gradually the external surface of this cloud-mantle radiated its heat into space—a very slow process, and one that might have taken ages to get rid of five degrees of temperature—and allowed the large overplus of carbonic acid to be deposited in the forms of limestone and mineral coal. The earth was now no longer "without form," but void.

Let us suppose so long a time to have elapsed that already the fervid body of our globe has cooled down to a comparatively low temperature—the dense mantle that once shrouded her has partially dissipated itself, but a gloomy obscurity still hangs over her, calculated to hold heat in an eminent degree. Water appears next *as* water, that before formed an element of the atmosphere only; in short, the waters were divided from the waters. The "firmament," as the early historian describes it, was not the cerulean expanse we are accustomed to see, but one of cloud scenery, through which the struggling sunbeams can with difficulty penetrate earthwards, obedient to the mandate of the Creator, "LET THERE BE LIGHT." After the appearance of land from out the waters which had been precipitated over the entire surface, vegetation made its way; but was it at all like the vegetation of the present day? I am inclined to think not. The part in nature that the vegetable world was to play had not been called on; other scenes were taking place on the great stage from which the curtain had but just gone up; the *Deus ex machinâ* of creation had not come on, and the full strength of the company was not yet required. I conceive this early vegetation to have been of a very luxuriant, though, generally, of a *fruitless* character, making up in mass of leaf and limb what it lacked in flower and fruit. This the large proportion of carbonic still in the atmosphere, and the dampness of the air, together with its high temperature, was calculated to bring about and to foster in the greatest degree. In this manner our coal-beds might have been stored; for it is hardly possible to conceive their formation under circumstances such as now exist. I conceive, moreover, that such a growth as I have described would have been highly necessary, in order to make a vegetable mould to mix with, and assist in the disintegration of the inorganic soil that must at first have formed the surface of the ground.

But the world was not destined to be the scene of the life and death of vegetation merely; and everything tended but to that higher purpose. The cooling proceeds to a yet lower temperature; the large amount of vapour which before had shrouded the earth began to be deposited freely; the sky often exhibited its blue tint; and, generally, meteorological processes were more in accordance with what they are at the present time. Vegetation now was required for the food of animal life, and therefore the *sun-light*, as well as heat and carbon, was necessary for its higher development. I conceive that it was at this epoch the two great *lights* were created which were to rule the day and night; for, although the sun was doubtless present when the rest of the system was made, the little light that penetrated the earth was only sufficient to *distinguish* day from night.

It is not necessary that I should follow up step by step the gradual cooling down of the atmosphere till it reached its present average temperature, which point it arrived at when the state of the sky no longer permitted the retention of heat, but, on the other hand, offered no resistance to the entrance of the radiated heat from the sun. The earth then derived its heat from the sun alone; a supply that is continually being received and given off, so keeping up a proper balance over the whole globe.

These notes on ancient temperatures are merely thrown out as *suggestions*, and not as final results, the product of any close investigation into the subject; I therefore beg that they will be received as such.

I had intended to offer some remarks on the latter portion of the paper, "the grand physical operations" that you conceive to have been at work in bringing about changes in the condition of our planet, but I fear that I have already extended my note beyond prudent limits, and therefore will defer any further observations, and remain, Sir, faithfully yours,

HENRY C. CRISWICK.

Greenwich, February, 1864.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

ROYAL INSTITUTION.—*January* 29.—"On the Glacial Epoch." By Professor Frankland, F.R.S.—Amongst the circumstances that have profoundly influenced the present physical condition of our earth, the action of ancient glaciers upon a scale of almost inconceivable magnitude has been gradually but irresistibly forcing itself upon the notice of philosophers since their attention was first called to it by Venetz and Esmark. There are few elevated regions in any quarter of the globe which do not exhibit indubitable evidence of the characteristic grinding and polishing action of ice-masses, although at present, perhaps, they are scarcely streaked by the snows of winter. In our own country the researches of Buckland, and especially of Ramsay, have clearly shown that the Highlands of Scotland, the mountains of Wales and Cumberland, and the limestone crags of Yorkshire, abound in these *roches moutonnés*, which leave no doubt that the valleys of those mountain ranges were once filled with glaciers of dimensions unsurpassed, if even equalled, by those which at the present day stream down the sides of their gigantic Swiss rivals. Nor was this perpetual ice of a former age confined to localities where no such phenomenon is now seen, but numerous observations have established that the glaciers of the present age, existing in Switzerland, Norway, and elsewhere, are but the nearly dried-up streamlets of ancient ice-rivers of enormous size. These glaciers have eroded the Alpine valleys, of which they once held possession, have carved out the lochs and kyles of Scotland, as well as the grander fjords of Norway, and have contributed in a most essential manner to the present aspect of our mountain scenery. Ramsay and Tyndall have recently called attention to this action of ancient glaciers, and have contended, with considerable plausibility—the former that the lake basins, the latter that the valleys of the Alps, have been thus, in great part, scooped out. In no part of the world, perhaps, can the phenomena of the glacial epoch be more advantageously studied than in Norway, where the ice-scarred coasts and fjords are still fully exposed to the eye of the observer, side by side with the ocean, which furnished the crystalline material that formerly covered them. Two thousand miles of coast, from Christiania to the North Cape, afford almost uninterrupted evidence of the vast ice-operations which, during the epoch in question, moulded nearly every feature of this remarkable country. Starting from Christiania, the traveller cannot fail to remark the peculiar appearance of the gneiss and granite rocks composing the coast, as well as the innumerable islands, which, forming a great natural breakwater, protect the shore from the heavy seas rolling in from the Atlantic. These rocks, here rarely rising to the height of 800 or 900 feet, present nothing of that sharp and rugged outline which generally characterizes such formations. On the contrary, they are smoothed even to their summits, all their angles worn off, and every trace of boldness and asperity effaced. To the casual and uninstructed observer the action of the sea suggests itself as a sufficient cause of these appearances; but it does not require much scrutiny to be convinced that the ocean waves have had little to do with this smoothing and polishing of the coast, since it is the surfaces sloping towards the land that are most acted upon; whilst in some places, where the rock descends precipitously towards the sea, and is subject to the dash of the waves, it has been protected from the abrading action, and presents merely a weathered surface.

Rounding the promontory of the Naze and proceeding northward, the coast presents, with slight exceptions, the same general features until the Arctic circle is approached, when the character of the scenery rather suddenly changes. The rocky hills acquire the dignity of mountains, and tower up in rugged, sharp, and fantastic peaks, contrasting strongly with the rounded summits of the lower latitudes. But these arctic peaks owe their immunity from the abrading action of ice solely to their height; around their bases, and even high up their sides, the slow surges of the moving glacial sea have made their unmistakable marks, grinding, and even undercutting, them into most extraordinary forms, as fine instances of which may be mentioned the Seven Sisters, and Torghatten, with its singular tunnel, just south of the Arctic circle; the Horseman, standing on the circle; and the mountains of the Folden and Vestjords, north of it: the latter having been justly described by the Rev. R. Everest as resembling the jaws of an immense shark.*

* The speaker was greatly indebted to his friend B. F. Duppa, Esq., for beautiful

To account for the advent and subsequent disappearance of such vast masses of ice, various hypotheses have been propounded. It has been suggested that the temperature of space is not uniform, and that our solar system, in performing its proper motion among the stars, sometimes passes through regions of comparatively low temperature: according to this hypothesis, the glacial epoch occurred during the passage of our system through such a cold portion of space. Some have imagined that the heat emitted by the sun is subject to variation, and that the glacial epoch happened during what may be termed a cold solar period. Others, again, believe that a different distribution of land and water would render the climate of certain localities colder than it is at present, and would thus sufficiently account for the phenomena of the glacial epoch. Finally, Professor Kämtz considers that at the time of the glacial period the mountains were much higher than at present—Mont Blanc 20,000 feet for instance—the Secondary and Tertiary formations having been since eroded from their summits.

The two last assumptions are attended with formidable geological difficulties, especially when it is considered that the phenomena of the epoch in question extended over the entire surface of the globe; they have therefore never acquired more than a very partial acceptance. With regard to the two first-named hypotheses, my colleague, Professor Tyndall, has recently shown that they are founded upon an entirely erroneous conception of the conditions necessary to the phenomena sought to be explained. The formation of glaciers is a true process of distillation, requiring heat as much as cold for its due performance. The produce of a still would be diminished, not increased, by an absolute reduction of temperature. A greater differentiation of temperature is what is required to stimulate the operation into greater activity. Professor Tyndall does not suggest any cause for such exalted differentiation during the glacial epoch; but he proves conclusively that both hypotheses, besides being totally unsupported by cosmical facts, are not only incompetent to constitute such a cause, but also assume a condition of things which would cut off the glaciers at their source, by diminishing the evaporation upon which their existence essentially depends.

The speaker divided the great natural glacial apparatus into three parts—viz. the evaporator, the condenser, and the receiver. The part performed by the ocean as the evaporator is too obvious to need description. The two remaining portions of the apparatus, however, are generally confounded with each other. The mountains are in reality the receivers, or *icebearers*, and are only in a subordinate sense condensers. The true condenser is the dry air of the upper region of the atmosphere, which permits of the free radiation into space of the heat from aqueous vapour.*

All the hypotheses hitherto propounded having therefore failed, in the light of recent research, to account for the conditions which brought about the glacial epoch, the speaker felt less reluctance in advancing a new theory, which had gradually elaborated itself out of the impressions he had received during a recent visit to Norway. Any such theory must take cognizance of the following points in the history of the glacial epoch:—1st,

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coloured drawings of these remarkable objects, taken from the sketches of Professor James D. Forbes and Mr. Mattieu Williams.

* This radiation from aqueous vapour was experimentally shown by causing a jet of dry steam to pass in front of, and at a distance of two feet from, a thermo-electric pile; the galvanometer connected with the latter promptly showed a large deflection for heat, proving that the pile was receiving radiant heat from the aqueous vapour. A jet of air heated in the same manner and projected in front of the pile produced no such effect.

that its effects were felt over the entire globe. 2nd, that it occurred at a geologically recent period. 3rd, that it was preceded by a period of indefinite duration, in which glacial action was either altogether wanting, or was at least comparatively insignificant. 4th, that during its continuance atmospheric precipitation was much greater, and the height of the snow-line considerably less than at present. 5th, that it was followed by a period extending to the present time, when glacial action became again insignificant.

All these conditions he believed to be the natural sequences of the gradual secular cooling of the surface of our globe. *The sole cause of the phenomena of the glacial epoch was a higher temperature of the ocean than that which obtains at present.*

He then examined the grounds upon which this hypothesis is based. Numerous observations of the augmentation of temperature, at increasing depths from the surface of the earth, no longer leave room for doubt that the vast mass of materials constituting the interior of our globe is at the present moment at a temperature far higher than that of the surface. If this be so, the conclusion is almost inevitable, that at earlier periods of the earth's history this high temperature must, at all events at depths comparatively little removed from the surface, have been still higher, and that consequently the temperature of the surface itself must in former ages have been much more influenced by the internal heat than is the case at the present day. Tracing thus back the thermal history of our earth, it is conceivable that the waters of the ocean once existed as aqueous vapour in our atmosphere,—a condition which it is imagined obtains at the present day in Jupiter, Venus, and other planets, whose superior size or closer proximity to the sun may be supposed to have retarded the refrigeration of their surfaces. From the period, therefore, when the cooling of the earth's crust permitted the ocean to assume the liquid condition, its waters have gradually cooled from the boiling-point down to the present temperature, whilst the land has also undergone a similar process of refrigeration. *It was during the later stages of this cooling operation that the glacial epoch occurred.* For this assumption, however, it is necessary to establish that the rate of cooling of the land and of the ocean surfaces was unequal, otherwise the more rapid evaporation of the ocean due to increased temperature would be more or less neutralized by the impaired efficiency of the proportionately warm icebearers. The speaker then proceeded to describe the results of his numerous experiments, which conclusively proved that, under the conditions contemplated, the land would cool more rapidly than the sea. This effect is brought about principally by two causes, viz. the great specific heat of water compared with granite and other rocks, and the comparative facility with which radiant heat escapes from granite through moist air. The amounts of heat associated with equal weights of water and granite are as 5 to 1 in favour of the former, or, if equal volumes be taken, the water requires to lose twice as much heat as the granite in order to cool through the same number of degrees: but it is in regard to the escape of radiant heat from their surfaces that the superior retention of warmth by the oceanic waters is most strongly marked. The readiness with which radiant heat escapes from equal surfaces of water and granite at the same temperature through perfectly dry air is nearly equal; but so soon as aqueous vapour is interposed in the path of these rays, the conditions become wonderfully altered; the escape of heat from both is interrupted, but its radiation from the water is retarded in by far the greatest degree. This extraordinary intranscalency of aqueous vapour to rays issuing from water has just been conclusively proved in the physical laboratory of this Institution by researches made by Professor Tyndall, and not yet published. The difference between granite and water arising from this cause becomes vastly augmented when it is considered that the icebearing surfaces occupy an elevated position above the level of the sea, consequently the mantle of aqueous vapour which their radiant heat had to penetrate must have been much more attenuated than the comparatively dense shell lying between them and the surface of the ocean. Thus the obscure rays of heat streamed into space from the icebearing surfaces with comparatively little interruption, whilst the radiation from the sea was as effectually retarded as if the latter had been protected with a thick envelope of non-conducting material.

Whether we take into consideration, therefore, the conductivity of water and granite, their specific heats, or, finally, the respective facilities with which they can, under the cosmical conditions contemplated, throw off their heat into space, we find everywhere a state of things tending much more to the conservation of the heat of the water than to the retention of that of the land; and this of course applies also, *mutatis mutandis*, to the retention of that heat which is received from solar radiation. The luminous heat-rays of the sun pass freely through aqueous vapour, and are absorbed by both granitic and oceanic surfaces, but, once absorbed, these rays issue forth again as obscure heat of two different qualities or rates of vibration. To use Tyndall's beautiful explanation of the phenomenon, the vibrations of the liquid water molecules are of such rapidity as can be best taken up and absorbed by the same molecules in the vaporous condition. But granite is a very complex substance, and fewer of the heat-oscillations of its atoms are in unison with those of aqueous vapour; hence the heat-vibrations of granite disturb the molecules of aqueous vapour in their passage through the atmosphere in a less degree, and consequently the granitic rays are less absorbed.

Thus, whilst the ocean retained a temperature considerably higher than at present, the icebearers had undergone a considerably greater refrigeration. The evaporation from the ocean would therefore, at the period contemplated, be greater than it is at present, whilst the capabilities of the icebearers, as such, would not be perceptibly less. Moreover, it is evident that, during the whole of the cooling period, the ocean must have been receiving heat from its floor, and thus have acted as a carrier of warmth from the comparatively profound portions of the earth's crust to the oceanic surface. It thus resembled a mass of water contained in an evaporating basin, placed over a very slow and gradually declining fire. Under such conditions its cooling was protracted through a vast period, allowing sufficient time, between a temperature inimical to animal life and the commencement of the glacial epoch, to permit of the development and decay of those forms of animal life which existed in the preglacial seas.

Temp. F.	Evaporation per minute in Calm.	Evaporation per minute in Breeze.	Evaporation per minute in High Wind.
	Grains.	Grains.	Grains.
85°	4·92	6·49	8·04
75°	3·65	4·68	5·72
65°	2·62	3·37	4·12
55°	1·90	2·43	2·98
45°	1·36	1·75	2·13
35°	·95	1·22	1·49

The rate of evaporation of water at different temperatures and under various circumstances was determined by Dalton, whose results are embodied in the foregoing table. The evaporation took place in each case from a circular surface six inches in diameter.

We have no sufficient data to calculate the present mean temperature of the ocean, but in lat. 69° 40′ off the coast of Norway, at noon on a remarkably hot summer's day, Professor Forbes found the temperature to be 46·5° Fahr. The assumption of 40° Fahr. as the mean temperature off the coast of Norway, would therefore probably be in excess of the truth. Now, taking the mean of Dalton's results obtained at 35° and 45°, and comparing it with the mean of his results at 55° and 65°, it will be seen that an increase of 20° in the temperature of the ocean off the coast of Norway would double the evaporation from a given surface. Such an increased evaporation, accompanied as it necessarily must be by a corresponding precipitation, would suffice to supply the higher portions of the land with that gigantic ice-burden which groaned down the mountain slopes during the glacial epoch.

But would not the increased oceanic temperature tend to augment the mean temperature of the atmosphere even at considerable elevations, and thus raise the snow-line and reduce the area of perpetual snow? In answering this question, the speaker showed that the limit of perpetual snow does not depend so much upon the mean temperature of the atmosphere at that particular elevation, as upon the amount of snow accumulating during the cold season. Under the equator, the mean temperature of the snow-line is 35° Fahr.; in the Alps and Pyrenees, about 45°; and in lat. 68°, in Norway, it is only 21°. Thus the mean temperature of the snow-line rises as we approach the equator, which means that the snow-line itself descends below its normal height, owing principally to augmented oceanic evaporation accompanied by increased atmospheric precipitation. The deluges of rain which fall within the tropics far surpass the rainfall in the temperate and frigid zones, and doubtless the fall of snow upon intertropical mountains is proportionately great. The important influence which the amount of precipitation exercises upon the lower limit of perpetual snow is beautifully exemplified at the fine waterfall of Tysse Strenger, near the head of the Hardanger Fjord, and was first noticed by Mr. M. Williams. The spray from this fall, being frozen in winter, covers the valley for nearly half a mile with a stratum of snow and ice, so thick as to defy the solar rays of summer to melt it; thus lowering the snow-line by more than 2000 feet. The speaker had also seen in the Sör Fjord, under similar abnormal conditions, a mass of snow lying, in the month of August last, within 10 feet of the level of the sea, although the normal snow-line is there at least 4500 feet above the sea-level. That the height of the snow-line is essentially dependent upon the amount of precipitation, and

Latitude.	Height of Snow-line in feet.		
	Coast.	Interior.	Difference.
60°	5,500	4,450	1,050
62°	5,200	4,150	1,050
64°	4,200	3,650	550
66°	3,700	3,250	450
68°	3,450	3,000	450
70°	3,350	2,900	450

not upon mean temperature, is evident from a comparison of its height on the coast and in the interior of the Scandinavian peninsula, as given by Forbes in the accompanying table, compiled partly from his own observations, and partly from those of Von Buch, Naumann, and others.

Thus the difference between the height of the snow-line near the coast, where, owing to the impact of the gulf-stream, the winter is mild but the atmospheric precipitation great, and in the interior, where the climate is severe but the air comparatively dry, amounts in some cases to as much as 1050 feet, or nearly one-fourth of the total height. Such is the depressing effect of greater precipitation as regards the limit of perpetual snow; nor must it be forgotten that copious precipitation is altogether incompatible with great summer-heat. The incessantly clouded sky cuts off the solar rays, and moderates the summer temperature. It is a trite observation, that a wet summer is always a cold one. The mean temperature of the land in contiguity with such extensive surfaces of snow could also not fail to be considerably reduced; for although the actual amount of heat in activity at the surface of the earth was greater during the glacial period than subsequently, yet the cold of winter became stored up in masses of falling snow, which in melting absorbed the heat of the succeeding summer, and thus reduced both the mean and summer temperature of the land, especially of such portions of it as were not situated greatly below the snow-line. The common notion, therefore, that the glacial epoch was a cold one, is correct, although heat, not cold, was the *cause* of that epoch. This apparent paradox, that heat should be the cause of cold, finds its parallel in the ice-making machines which were in operation at the last Great Exhibition. In those machines which produced from 2 to 12 tons of ice per ton of coal, the glacial produce was directly proportional to the amount of heat developed by the combustion of coal.

But it is evident that this lowering of the snow-line by increased oceanic temperature could only occur within certain limits; for, although the mean temperature of the snow-line might rise from 21°, its present position in Norway, to 35°, its height under the equator, and perhaps even still higher, without any elevation of the snow-line itself, yet a further rise of mean temperature, which would result from a continued augmentation of oceanic heat, could not fail to elevate the snow-line itself, and eventually to chase the last portions of snow even from the loftiest mountain peaks. A process the inverse of this has gone on in nature, leading gradually to the glacial epoch, and eventually to the present meteorological condition of our globe. Whilst the ocean maintained a high temperature, the snow-line floated above the summits, possibly even of the most lofty mountains; but with the reduction of oceanic temperature it gradually descended, enveloping peak after peak in a perennial mantle, until during the glacial epoch it attained its lowest depression, whence it again rose, owing to diminished evaporation, to its present position.

The speaker considered that, inasmuch as recent researches had rendered all previous hypotheses regarding the glacial epoch absolutely untenable, the one for which he now contended could not be said to come into antagonism with any other views. It also further commended itself by requiring the assumption of no natural convulsion or catastrophe, no vast or sudden upheavals or depressions, and no change in the thermal relations of our earth to the sun or to space. On the contrary, it insisted that the glacial epoch was normally and gradually evolved from a thermal condition of the interior of our globe, which could scarcely be said to be any longer the subject of controversy.

In conclusion, this hypothesis suggests the probability that the other bodies belonging to our solar system have either already passed through a similar epoch, or are destined still to encounter it. With the exception of the polar ice of Mars, we have hitherto obtained no certain glimpse into the thermal or meteorological condition of the planets; neither is the physical state of their surfaces accessible to our best telescopes. It is otherwise however with the moon, whose distance is not too great to prevent the visibility of comparatively minute details. A careful observation of the lunar surface for more than a year with a silvered-glass reflector of 7 inches' aperture and of good defining power, had created in the speaker's mind an impression that our satellite had, like its primary, also passed through a glacial epoch, and that several, at least, of the *valleys*, *rills*, and *streaks* of the lunar surface were not improbably due to former glacial action. Notwithstanding the excellent definition of modern telescopes, it could not be expected that other than the most gigantic of the characteristic details of an ancient glacier-bed would be rendered visible. Under favourable circumstances the terminal moraine of a glacier attains to enormous dimensions; and, consequently, of all the marks of a glacial valley, this would be the one most likely to be first perceived. Two such terminal moraines, one of them a double one, appeared to him to be traceable upon the moon's surface. The first was situated near the termination of that remarkable streak which commences near the base of Tycho, and passing under the south-eastern wall of Bullialdus, into the ring of which it appears to cut, is gradually lost after passing crater 216 (Lubinietzky). Exactly opposite the last crater, and extending nearly across the streak in question, are two ridges forming the arcs of circles, whose centres are not coincident, and whose external curvature is towards the north. Beyond the second ridge a talus slopes gradually down northwards to the general level of the lunar surface, the whole presenting an appearance reminding the observer of the concentric moraines of the Rhone glacier. These ridges are visible for the whole period during which that portion of the moon's surface is illuminated, but it is only about the third day after the first quarter and at the corresponding phase of the waning moon (when the sun's rays, falling nearly horizontally, throw the details of this part of the surface into strong relief) that these appearances suggest the explanation now offered.

The other ridge, answering to a terminal moraine, occurs at the northern extremity of that magnificent valley which runs past the eastern edge of Rheita. This ridge is nearly semicircular, and is considerably elevated, both above the northern termination of the valley and the general surface of the moon. It may be seen about four days after new and full moon, but the position of the observer, with regard to the lights and shadows, renders its appearance in the rays of the rising sun by far the most striking.

With regard to the probability of former glacial, or even aqueous, agency on the surface of the moon, difficulties of an apparently very formidable character present themselves. There is not only now no evidence whatever of the presence of water, in any one of its three forms, at the lunar surface; but, on the contrary, all seleniographic observations tend to prove its absence. Nevertheless, the idea of former aqueous agency in the moon is by no means new. It was entertained by Gruithuisen and others. But if water at one time existed on the surface of the moon, whither has it disappeared? If we assume, in accordance with the nebular hypothesis, that the portions of matter composing respectively the earth and the moon once possessed an equally elevated temperature, it almost necessarily follows that the moon, owing to the comparative smallness of its mass, would cool much more rapidly than the earth; for whilst the volume of the moon is only about $\frac{1}{49}$th, its surface is nearly $\frac{1}{13}$th that of the earth.

This cooling of the mass of the moon must, according to all analogy, have been attended with contraction, which can scarcely be conceived as occurring without the development of a cavernous structure in the interior. Much of this cavernous structure would doubtless communicate by means of fissures with the surface, and thus there would be provided an internal receptacle for the ocean, from the depths of which even the burning sun of the long lunar day would be totally unable to dislodge more than traces of aqueous vapour. A globe of wax was exhibited which had been cast under water; it was highly cellular, and the water had been forced into the hollow spaces, completely filling them. Assuming the solid mass of the moon to contract on cooling at the same rate as granite, its refrigeration through only 180° F. would create cellular space equal to nearly 14½ millions of cubic miles, which would be more than sufficient to engulf the whole of the lunar ocean, supposing it to bear the same proportion to the mass of the moon as our own ocean bears to that of the earth.

If such be the present condition of the moon, we can scarcely avoid the conclusion that a liquid ocean can only exist upon the surface of a planet so long as the latter retains a high internal temperature. The moon then becomes to us a prophetic picture of the ultimate fate which awaits our earth, when, deprived of an external ocean and of all but an annual rotation upon its axis,* it shall revolve round the sun an arid and lifeless wilderness,—one hemisphere exposed to the perpetual glare of a cloudless sun, the other shrouded in eternal night.

NOTES AND QUERIES.

Geology of Sharpness.—The following passages, from a paper by Mr. John Jones, of Gloucester, read before the Cotteswold Club, are interesting:—"The district to which we shall chiefly direct attention at present is that which lies between Sharpness Point and the Hock Crib, at Fretherne (the 'Scearp-Nesse,' 'Acute Promontory,' and the 'Hock Crib,' or 'curved lying-place'), comprising the 'New Grounds,' so called from their having been formed and reclaimed from the Severn at a very recent period. . . .

"Crossing the wooden bridge, over the sluice which allows the waste waters of the canal to escape, we approach the place at which the ferry-boat from Pyrton, on the opposite side, lands its passengers; the names of both being probably derived from the same Anglo-Saxon elements of Pertún, 'the dwelling on the pier,' and evidencing the antiquity of the ferry, the rights pertaining to which are still strictly enforced by the lessee. An interesting chapter in practical geology may be read by the initiated from this spot.

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* Mayer has recently proved that the action of the tides tends to arrest the motion of the earth upon its axis. And although it has been proved that since the time of Hipparchus the length of the terrestrial day has not increased by the one-hundredth part of a second, yet this fact obviously leaves untouched the conclusion to which Mayer's reasoning leads.

"We stand nearly upon the summit of the protruded Silurian dome, represented in a coloured section, published in the first edition of Murchison's 'Silurian System,' and may find in abundance under our feet characteristic shells and corals of the Upper Ludlow beds, though much damaged by the action of the tidal waters. The colour of this rock differs so little from that of the Old Red Sandstone beds which once rested immediately upon it, and still flank it, that the precise point of contact is difficult to discover.

"Upon the opposite shore, full in our view, are the Old Red Sandstone rocks which form the upturned edges of the Forest of Dean coal-basin, the equivalents of the cornstones, and show at a glance, by the well-marked anticlinal lines of their strata, dipping from one point towards Lydney, and from another towards Gloucester, the wave-like character of the motion of the subjacent beds, by which their elevation, with that of the Silurian rock just mentioned, was effected, and their curvatures produced. The transverse section, showing how this last passes under the others, appears to us to be of equal interest to the published section, and we have here ventured to produce it, from such observations as the constantly-changing bed of the river has enabled us to make; remarking, that from the inaccessibility of the former, the Club would confer a boon upon its members by republishing it.

"Walking along under the cliff towards the Berkeley Arms Inn, from the seat in front of which the finest view of the district, to be seen from the river, may be obtained, we arrive at the mass of Old Red Sandstone, anticlinal to that over which we have just passed, upon which the house stands, although, from the amount of silt deposited within the last ten or twelve years, the point of junction is obscured; and crossing the road leading to the pier, we come at once to the Lias beds, which form the well-known Purton section, reposing unconformably upon the same. Some forty years since, the principal channel ran under this cliff; but, from the operation of the breakwater commenced by the late Earl Fitzhardinge, land is rapidly forming here, and the current has been diverted to the Forest of Dean side. The alluvial deposit behind the breakwater, in the direction of our course, from its yet unstable character, renders it difficult to trace the Liassic beds from their immediate line of contact with the Devonian; but at the distance of about half a mile from the inn they become accessible. . . .

"Few scenes can more vividly impress themselves upon the mind of a young geologist than that which presents itself here after a fall of the rock, and its exposure for a few weeks to the tidal and atmospheric action. The beach is sometimes strewn with fossils in the finest possible condition, more especially as regards Gryphites, which are found of every type conceivable within the limits of one species; and that one only exists here, the writer has endeavoured to prove in a former paper, now forming a part of the Transactions of the Cotteswold Naturalists' Club. . . . (See notice in a former volume of the 'Geologist.')

"We have now arrived at the end of the cliff near the second breakwater. Higher up the vale of Gloucester, it is difficult to obtain a clear idea of the correlation of the vast beds of gravel composed of the detritus of the Liassic and Oolitic beds of the neighbouring hills, containing elephant and hippopotamous remains, occasional chalk-flints, etc., with what is popularly known as the *Northern* Drift (but to which appellation we conceive that there are substantial reasons for objecting). Be that as it may, the order of superposition is well shown in a small excavation within a few yards of the breakwater upon the edge of the cliff, where a bed of the gravel above-mentioned has been worked to a small extent.

"Upon the gravel rest two or three feet of vegetable soil, over which is strewn another bed of similar gravel, an inch or two only in thickness, and over all, under the existing herbage, the quartzose and red sandstone pebbles of the (so-called) Northern Drift. Taking our stand at this point, and scanning the vale with the eye of a geologist, we may readily trace the sequence of all the deposits of which the elements of the landscape around us consist. We cannot doubt that the Lias upon which we stand once stretched across what is now the channel of the Severn, and rested upon the Red Sandstone, as corresponding beds do at present on the opposite shore at Awre, near Poulton Court. Looking directly up the river, we may see distinctly, with the aid of a glass, the same bed stretching away in a corresponding direction at the Hock Crib, and we know that a few miles beyond this lies Westbury Cliff, where the lowest beds of the Lias rest upon the New Red marls; and these being at Flaxley, unconformably placed against the Upper Silurian rock, thrown up near Sir Martin Crawley's schools, enable us to judge at what period the great disturbance of the Protozoic formations in this neighbourhood took place.

"All these, from the Mayhill Sandstone to the upper beds of the Carboniferous system, had been placidly deposited in their due order in the depths of a vast sea.

"The section of the Forest Coal-field, in any direction shown upon the maps of the Geological Survey, indicates no relative disturbance of its component strata prior to that effected by the turning-up of its edges by the protrusion of older rocks, which form the tracts which separate it from the neighbouring coal-fields of Bristol and Glamorgan, the central portion remaining comparatively undisturbed. The relations of the Secondary to the Protozoic and eruptive rocks of the district are everywhere the same, and the line of unconformity between them may be traced from the trap boss at Tortworth, behind us, on the S.E., to the flanks of the Malvern range, before us, on the N.W. Wherever first or last exerted, we know that the cosmic force by which that great Sienitic mass was abruptly uplifted produced the contortions of the Silurian rocks around it, and the undulations of those before us and under our feet; passing hence, still upheaving Silurian strata through those of the Devonian age, and penetrating these again at Tortworth with a mass of trap, it subsides from this point under the Bristol coal-field, to produce effects analagous to those already described around and beyond it. It is not our object to trace further the development of this force and its consequences, but to bring more prominently forward than they have hitherto been brought in the Transactions of the Club, those geological features, easily accessible at many points in this country, by which we ascertain, approximatively, the period at which these commotions, to which we at present owe the diversity of its soil, and scenery, and access to its mineral wealth, took place. In and around the Forest we have precipitous escarpments of Carboniferous limestone and shales, with those of older rocks, in such position as to prove how great must have been the extent of their detritus, carried away we know not whither. As the ancient detritic material of the lowest and most compact strata—which would necessarily be the most recent, and the last exposed to aqueous action—has left no trace of its existence here, we may reasonably expect to discover any débris of the higher strata which once reposed upon these.

"We have no traces in the Forest area, for example, of the Magnesian Limestone and its associated beds, which in other parts of England, and upon the Continent, follow in regular series those of the Carboniferous system; yet we find at Bristol a Magnesian conglomerate, with the remains of undoubted Permian reptiles, and as we cannot believe, from the sharp angles of the rock-fragments of which it is composed, that they have travelled any considerable distance, we must necessarily suppose that the formation, of which it is the representative, *was* to some extent developed here.

"We have seen the upper beds of the New Red Sandstone deposited unconformably against the upthrown Silurian and the Old Red, at Flaxley and elsewhere; the Lias against the Old Red Sandstone, as here; and upon Silurian strata, as near Eastwood; Mr. Charles Moore has informed us that the fissures of the Carboniferous Limestone of his district contain Liassic fossils; and Mr. Etheredge has shown us a specimen of the same limestone bored by Lithophagidæ, at whose death their holes were filled up by then-forming Oolitic granules.

"Under these circumstances, as we are not acquainted with any group of strata intermediate to the Permian and Triassic formations, and as we do not find these in contact here, may we not reasonably infer that beds of Permian age *had* been deposited here in their due sequence, but having been swept away, either prior to, or in consequence of, their disruption by the disturbances indicated, when the deposition of the Triassic formation commenced, the forms of life which characterized them are here wanting, and the Mesozoic, which characterize the next vast epoch, have assumed their places? . . .

"A glance at the great Lias outlier of Robinswood Hill, looming up from the centre of the vale, reminds us that since the changes we have contemplated, others as remarkable have taken place; for we recollect that this must once have been conterminous and continuous with the Liassic slopes of the Cotteswolds, which form the background of the landscape, and flank it on the right. These, we know, are merely capped by beds of the Inferior Oolite, the detritus and fossils of which, mingled with those of the Lias, strew the valley from beyond Evesham to the quarry on the cliff which we have already visited, evidencing action to which they have been subjected, by which the deep combs and bays which indent them have been formed. The recent origin of the gravels is apparent from the remains of the great extinct pachyderms still found amongst them, and occasionally the shells of mollusca still existing around us.

"We have expressed some doubt as to the origin of the drift which overlies these gravels, to which the epithet 'Northern' has been expressly applied, because, the further we travel south-westward, the heavier and larger do we find the pebbles which constitute it become, and we may reasonably suppose that the smaller detritus wanders furthest from its parent rock. There may, indeed, have been an influx of similar material at the other end of the valley, but from its sparsely-scattered condition, and the minuteness of the fragments of which it is here composed, we feel rather disposed to ascribe to it a south-westerly than a northern origin. As compared with these drifts, the Severn Channel is of modern formation, for we see at this point that its bed is worn through them and their underlying gravels,—a circumstance which the want of coherence, and difference in the rock-materials here in juxtaposition, must have much favoured.

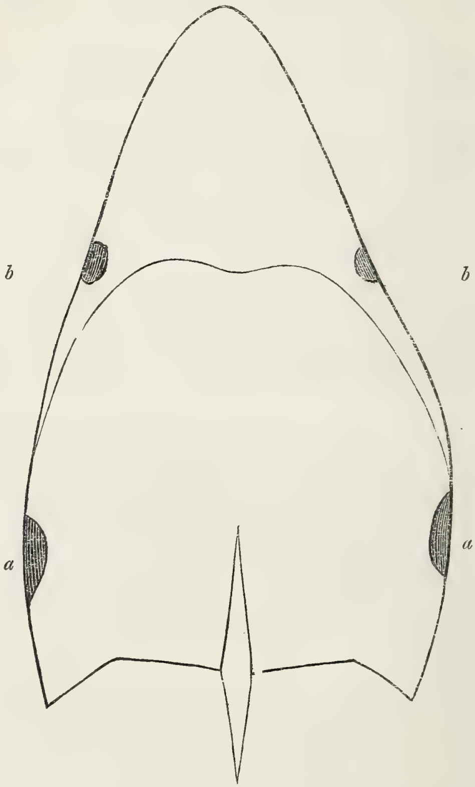
"Another feature of great interest in this district, to which our attention was first called by Mr. Clegram, is the existence of an extensive bed of peat, in which are found trunks and roots of trees, principally oak, in the ordinary state of what is popularly known as bog-oak. These may be best seen on the sides and in the bed of the watercourse called the Royal Drough, in the excavation of which they were first brought to light. They are accompanied by the catkins of hazel, and the leaves of waterflags and other plants, which show that they could not have been transported far from the place in which they grew. The thickness of the peat-bed is from four to five feet, and it is some feet below the level of high-water mark, covered by brick-earth, of the same character as that still deposited by the Severn, to the depth of ten or twelve feet, indicating that it must have been submerged to a sufficient depth for this accumulation to have been formed upon it, and subsequently uplifted to its present position. The same deposit is found on the opposite bank of the river, in the parish of Awre, and, as we are informed, on Walmer Common, in the parish of Westbury-on-Severn, at Whitminster, and in other places near Gloucester, from which its extent may be inferred. We are not aware that these facts have been previously noticed by other writers.

"The trees, when fairly uncovered in excavation, occur in great numbers, and very large 'stag horns' were found amongst them, some of which are said to have been taken to Berkeley Castle.

"An entire skull of the *Bos primigenius* was found in the Severn, not very far from Sharpness Point, near the spot where the fresh water of the Royal Drough, on the bank-cuttings of which these trees are now best seen, and which runs in places through the peat-bed, still keeping open a channel through the sands."

Restoration of Pteraspis.—Dear Sir,—In the May of last year I addressed a brief note to you, partly concerning the restoration of the test of Pteraspis, and which has been several times discussed by other correspondents and myself in the pages of your valuable magazine. Since then I have got from our Scottish rocks various additional fragments of Pteraspis, and a nearly complete specimen; and as it seems to cast light on some points already mooted and made matter of controversy, I trust you will allow it to be figured along with this communication.

I may say that I have both the specimen and its cast in the stone, and have attempted the outline of the test according to actual measurement. It will be observed by your readers, who take the trouble of looking back to previous numbers of the 'Geologist,' that this outline-figure closely resembles that contributed by Mr. Powrie to your February number of 1863. The specimen now before us differs from that of Mr. Powrie in size, although akin to each other in the relative proportions of their component parts. They differ however considerably in two other features which I am about to notice. First, the terminal edge on either side of the central prolongation or spine is not continuous in this new specimen, but is broken into segments; and, secondly, there is evidence of a protuberance, or it may be perforation (*a*, *a*), which I have not observed figured in any of the previous diagrammatical restorations of Pteraspis. I cannot certainly determine from my specimen whether it is perforation or protuberance, although I incline to think the former. I have no doubt however of what have been called the eye-orbits (*b*, *b*) being perforations, as the bony substance is exceedingly well preserved at that part of the test in the specimen before me, and the matrix is seen piercing the distinctly-defined orbital space. It has been thought by some that these anterior perforations are the nostrils, and if so, a conjecture may be hazarded that these posterior perforations are the eye-holes; but they may have served some other end in the economy of the organization of this curious old-world fish. This specimen exhibits very beautifully the characteristic internal structure of the plates as so well described by Professor Huxley. When looked at through a glass of feeble magnifying power, nothing can exceed the beauty of the external layer of bone, either in the regularity of the wave or in the grace of the curve of the ridges. It may be otherwise in the English Pteraspides, but no Scottish specimen, which I have seen, presents us with the cornua so fully developed in the kindred Cephalaspis.



I may add that I have had no further light thrown on the nature of the protection of the under side of the head of Pteraspis. I can only see, from the specimens I possess, that the plate of the upper side has a broad marginal rim or border turning downwards or inwards, but whether to lock into another plate I cannot affirm. HUGH MITCHELL.

Craig, February 13, 1864.

FLINT IMPLEMENTS.—Sir Charles Lyell says, in his 'Antiquity of Man,' that flint-implements have occasionally been found on the beach between Herne Bay and the Reculvers, and that they are somewhat rare, since, so far as is known, not more than about twelve have been met with there. The most recent find is, I think, in my possession. In August, 1863, I spent some little time in attempting to discover the formation from whence these flints are derived, by, if possible, finding one *in situ;* failing in that, I determined to search the beach, and there saw one lying on its flat side on the shingle. It differs from those presented by Mr. Leech to the Jermyn Street Museum, which are from the same locality, in being smaller, much less pointed, and flatter at the base. Its length must have been 5 inches, and its greatest breadth 3¾ inches, exactly corresponding to the oval shape and size of the Amiens flint presented by Mr. Prestwich to the same museum. The edges are much fractured, either from use or water-rolling, probably both. GEO. J. STRONG.

Queen's Printing Office.

PHOSPHORUS IN NATURE.—This element is found in minute quantities almost everywhere in nature; it is an essential constituent of fertile soils, and of all living organisms. But people have been rather puzzled to account for the mountains of apatite (crystalline phosphate of lime) which have already been found in one or two parts of Europe, and which may exist in other quarters of the globe. We quote the explanation in Dr. Hofmann's Report of the Chemical Products and Processes in Section A of the International Exhibition:—"Large masses of phosphorus are, in the course of geological revolutions extending over vast periods of time, restored from the organic reigns of nature to the mineral kingdom by the slow process of fossilization, whereby vegetal tissues are gradually transformed into peat, lignite, and coal; and animal tissues are petrified into coprolites, which, in course of time, yield crystalline apatite." And then:—"After lying locked up and motionless in these forms for indefinite periods, phosphorus, by further geological movements, becomes again exposed to its natural solvents, water and carbonic acid, and is thus restored to active service in the organisms of plants and the lower animals, through which it passes, to complete the mighty cycle of its movements, into the blood and tissue of the human frame. While circulating thus, age after age, through the three kingdoms of nature, phosphorus is never for a moment free. It is throughout retained in combination with oxygen and with the earthy or alkaline metals, for which its attraction is intense."

TRADITIONS OF THE DELUGE AND OF THE UNITY OF ORIGIN OF MAN.—The subject of traditions was brought under discussion at a late meeting of the Ethnological Society, by a paper by the Rev. Mr. Farrar, who in general terms objected to the race-values, as well as the antiquity of traditions. One point is, however, in a geological aspect, I think, worthy of examination. I am under the impression that the tradition of a universal deluge, and of the descent of mankind from a single pair, is characteristic of the Caucasian races. Now the glacial era was seemingly inaugurated with unequalled copious rains, and passed away as a geological age in a multitude of debacles, seemingly from the melting of the vast quantities of snow and ice accumulated during that intensely cold period. The relics of man are found fossil in the deposits of at least the close of this period, and therefore primitive man would have been at least an eye-witness of the later debacles, if not of the inaugurating rains. To get out of the Gorilla-origin theory for a time, and to look justly at facts, we find the oldest fossil human skull—the Engis—belonging to the Caucasian or European type. If, then, the Caucasian peoples should be proved to be the only original preservers of the tradition of the deluge and single-pair parents of the human race, would it not be very confirmatory presumption in favour of the greater antiquity of European man, than of men of other species? We have nowhere got a fossil negro, and negroes have no traditions of these two popularly-believed events. If European man's antiquity extended to the debacles which closed the glacial age, there would be an original truth handed down to us in these legends; for although presented to us in an Asiatic aspect, there are race-characters in the Jews which should refer their primary origin to the European area; and although these glacial debacles produced no universal deluge, covering with its waters the tops of the highest mountains, yet local floods deluging so many and such various districts, would be so nearly coincident and contemporary in time, that their results would be practically, if not literally, universal.—S. J. Mackie.

Erratum.—P. 80, in communication from Mr. Pattison, *for* "Oltrungt" *read* "Oetrungt;" *for* "apparent Devonian" *read* "uppermost Devonian."

MISCELLANEOUS NOTICES.

The 'American Journal of Science' for January contains a translation of M. Perrey's Theory of Earthquakes, from his 'Propositions sur les Tremblements de Terre et les Volcans,' a continuation of Professor Dana's articles "On the Classification of Animals based on the Principle of Cephalization," the group of insects being taken up in the present number. There is also a short but most interesting note by the Professor, on some fossil insects from the Carboniferous formation in Illinois, accompanied by woodcut figures. These insect-remains were discovered by Mr. Bromson in the Carboniferous beds at Morris, Illinois. They occur in the flattened ironstone concretions of the beds, which also contain plant-remains and two or three species of Amphipod Crustaceans; one specimen is a Neuropter, closely like the Semblids, and especially the Chauliodes. The other specimen figured is also a Neuropter; it is a mutilated anterior wing, the neuration approximating to that of the genus Hemerobius. There is also an able paper on the "Density Rotation and Relative Age of the Planets," by Professor Henrichs, of the Iowa State University. The other articles are "On Tephroite," by Mr. Geo. J. Brush. Amongst the Notices—Unger's Scientific Results of a Tour in Greece and the Ionian Islands; Guyot's Physical Wall-Maps of the Continent; Professor Whitney on the Highest Mountains of the United States and of North America, and on the Survey of California; on the Constitution of Columbite, by H. Rose; Contributions to Palæontology, by Professor James Hall; Monograph of Fossil Estheria, by Professor Rupert Jones; Dana's 'Text-book of Geology;' Tract on Crystallography, designed for students of the University, by Mr. H. Miller, of Cambridge; Descriptions of Fossil Plants collected by Mr. Geo. Gibbs, Geologist to the U.S. North-west Boundary Commission, by Dr. J. S. Newberry.

THE GEOLOGIST.

APRIL 1864.

TWO OR THREE INCIDENTS IN A RAMBLE IN THE NORTH OF FRANCE.

By the Editor.

Having lived from infancy on the shores of the Channel, with the beautiful section of the Kentish coast constantly before my eyes, it is only natural that as a geologist I should take especial interest in the study of the Cretaceous Rocks, and being fully acquainted with their divisions, fossils, and details in my own district, I was desirous of instituting a comparison with those of the north of France, with which they are so intimately connected.

Narrow as are the straits which divide the two countries, considerable differences exist in the subdivisions of this formation as we proceed westward, and much is to be learnt from the study of the ancient condition of the various portions of the great oceanic basin of which both the strata of England and France alike are portions.

There was also another subject of much practical importance as well as scientific interest, which deserved to be studied on both coasts —the flint beaches. Constantly are they journeying from west to east; but where do they come from and whither do they go? From whence are they derived?

These were the objects for which, on the 3rd of September, 1854, I started for a month's ramble in the north of France. My health at the time was but very indifferent, and I was unequal to those exertions I should otherwise have made, and which were necessary to render the investigations and comparisons complete. Being, too, vacation-time, the Professors were generally absent from the towns, as were also most private families, and I thus lost much valuable assistance. Moreover, the antiquities and picturesque scenery of the Seine and the coast of Normandy proved so attractive, that my pencil was more employed than my hammer, and my sketch-book much fuller than my havresac. In truth, I idled by the way, and the work I went for never has been done. Some of the incidents on that trip, however, deserve a better fate than oblivion, and are worth the jotting down.

The period of my ramble was one of immense political importance to all Europe—to the world,—of the deepest and most anxious moment to the two countries, of whose profoundly remote geological history I was patiently endeavouring to read a solitary passage, spelling the words by petrified letters, and hoping to add another line to the popular translation of that wonderful book, in the study of which so many earnest and enthusiastic lives have been spent, and which to have helped to have read is the dearly prized and true reward of the scientific man's ambition.

Upon the soil I trod our forefathers had fought and bled, and the flower of the world's chivalry had met in sanguinary conflict on the very spots where now to me the hand of friendship was sincerely given, and as warmly returned. Every one's attention was turned to the East, where England and France had sent the bravest of their sons. Our Armada had sailed, and there was no one without some relative, some friend in that vast fleet, far more powerful than that which stands out so proudly emblazoned on the page of Spanish history, but which the winds of heaven and a little gallant band of Englishmen dispersed.

The first distracting incident of my voyage was the landing of Prince Albert at Boulogne; the next the great review of 60,000 men at Marquise.

The district of Boulogne is one of great interest, not only as the completing portion of the great circle of the elevation of the Wealden districts of Kent and Sussex, but that it has been at a more remote period the seat of convulsions which have brought the older rocks, even the Silurians, to the surface; and the fossils of all the beds from the Chalk to the Primary Schists and Limestones, may be gathered in that region of the little old island that there protrudes through the sea-deposits of the Secondary rocks. I have often been surprised that this wonderfully diversified and miniature area should not have been more worked.

Then came Abbeville and its gravels, and its fine old church, and its statue in the market-place; then the glorious cathedral of Amiens. Then a week's gaiety in Paris, and more than another week spent at Rouen and along the Seine, until a temporary stay at Frascati's gave me the opportunity of commencing but not finishing a study of the cliffs of Havre. The main cliff, or *falaise*, consists of the Lower or Grey Chalk, which there contains numerous beds of large chert nodules, in similar manner to the bands of flints in our Upper Chalk. The subdivisions of these beds I could not completely make out from top to bottom, but the notes I made are sufficiently accurate as far as they go, and for this reason are worth giving side by side with the subdivisions of the French geologist, M. Le Sœur, in 1843, it being borne in mind that the thicknesses of the strata, as given by me, are estimated by eyesight only, and *not* by actual measurement.

I. *Subdivisions of the Cretaceous and Wealden Formations recorded by M. Le Sœur at the Cliff under the Lighthouse at Cap La Hêve*, 1843.

Terrain Diluvien :—
- Argile rouge; sable fin; silex pyromatique.

Craie Inférieure :—
- Craie chloritée grise; lits et rognons de silex.
- Bandes de silex.
- Craie glauconeuse blanche.
- Bandes de silex.
- Lits et rognons de silex.
- Bandes de silex.
- Craie glauconeuse blanche et rognons de silex.
- Bandes de silex noir.
- Craie glauconeuse brune; rognons de silex; polypiers.
- (*Sources.*)
- Lits tendres endurcis de glauconie verte.
- Lits de marne bleue noire pyriteuse, avec lits de silex calcédoneux.
- Gros gravier ferrugineux.

Section at Cap La Hêve (Mackie.)

		ft.	in.
	Double chert	0	8
1.	Chalk	0	10
	Ditto	1	4
2.	Chert	0	6
	Chalk	0	8
3.	Chert	0	6
	Chalk	1	0
	Parting.		
	Chalk	0	10
4.	Chert nodules, large and white	1	0
	Chalk		
5.	Chert nodules	0	8
	Chalk—weathers in.		
6.	Chalk	1	0
	Blue Parting.		
7.	Band of chert	0	10
8.	Greenish sandstone	0	9
9.	Greyish green-grained chert, wanting at places	0	6
10.	Greenish-yellow soft sandstone	0	6
11.	Band of cherty dark stone .	0	9
12.	Seam of dark-grey stone . .	0	8
	Micaceous friable sandstone (soapy)	0	8

Sable micacé grossier, fin roux, blanc, ferrugineux.
Lits de fossiles.

Terrains Jurassiques :—
Lits alternes de marne et de calcaire marneux.
Lits alternes de marne calcaire et de calcaire hydraulique, argile hydraulique, argile à briques.
(*Huitres.*)
Argile à briques.
Lignite.

——————— Sea-level.

(*Huitres.*)
Lits de marnes.
Calcaire marneux.
Oolite.
Marne bleue.

II. *Subdivisions of the same Formations as exposed in the Cliff beyond the Lighthouse, according to M. Le Sœur*, 1843.

Terrain Diluvien :—
Sol superficiel.
Argile rouge ; sable fin ; silex pyromatique.

Sable Vert ; CraieInférieure :—
Craie chloritée grise ; lits et rognons de silex.
Craie glauconeuse, blanche ; lits et rognons de silex.
Bande de silex.
Craie glauconeuse brune.
(*Sources.*)
Lits tendres endurcis de glauconie verte.
Lits de marne bleue noire pyriteux, avec des lits de silex calcédoneux.
Gros gravier ferrugineux.

Formation Wealdienne :—
Sable micacé quartzeux fin blanc roux ; veine de fer oxyde ; brun noirâtre, avec nombreuses veines ferrugineuses.

———————Ligne de la mer.

Terrain Jurassique :—
Calcaire marneux.

		ft.	in.
13.	Bed of friable rock, hardening into stone	2	0
	With base of dark brown-grey rock with clay streaks	0	3
14.	Blue Parting	0	4
15.	Blue friable chalk, which scales off by weathering .	1	4
	Soft parting.		
16.	Band of dark-blue stone, with two broad bands of rubbly chert, looking like a single bed of rubbly rag	2	9
	Parting of dark-blue phosphatic chalk	0	8
17.	Grey friable rock	0	8
18.	Semi-cherty dark-blue rag-like stone	1	6
19.	Dark-blue parting, with molluskite	9	8
20.	Hard dark bluish-grey stone, and cherty stone, forming the top portion of a thick bed of dark-grey stone with green grains, enclosing green chert and molluskite	2	0
	Softer portion which dries white.		
21.	Cherty dark bluish-grey sandstone, with some chert (*Ventriculites* and *Choanites*)		
22.	Parting.		
23.	Black phosphatic bed, passing into—		
24.	Rubbly bed of soft friable rock	1	6
25.	Bed of soft friable sandstone	1	2
26.	Soft parting	0	4
27.	Bed of dark cherty-looking grey hard stone, (double?)	6	6
28.	Softening into Hassock (?) like Sandgate rock . .	6	6
	Soft parting	0	3

(Carried forward.)

		ft.	in.
Lower Greensand ?	29. Dark stone-like hardened Sandgate-rock, with shells at base, and a few phosphatic nodules at top	0	6
	30. Black marly sands (like the Sandgate sand)	10	0
	31. Do. with phosphatic nodules	10	0
	32. Dark ferruginous grit, with concretions	8	0
	33. Pebble bed.		
	34. Greenish band	0	10
	And cindery Hassock (?) like Sandgate rock	4	0
Wld^{n} ?	35. Ferruginous sandstone.		
	36. White sand	10	
	37. Ferruginous sand.		

Section II. Equivalent to base of Section I. Taken nearer the Point of Cape (Mackie).

		ft.	in.
	31. Dark-blue bed with phosphatic nodules	10	0
	Dark ferruginous grit, with phosphatic nodules	8	0
	Grit	4	10
	Ferruginous sandstone.		
	Dark grit	10	0
	Pebble band.		
	35. Greenish band of cindery Hassock (?) like Sandgate rock.		
Wld^{n}	36. White micaceous sand.		
	37. Ferruginous sands.		

Since, however, the days when I scrambled over the rough undercliff and up the craggy face of Cap La Hêve, the important attention which has been given to the quaternary deposits and the geological traces of the human race, has rendered one spot which excited then my interest still more interesting. It is a deposit of siliceous sand, containing recent species of shells, underlying a capping of ordinary angular flint drift-gravel.

Between Frascati's well-known hotel and baths, near the pier at Havre, and the commencement of the chalk cliffs of Cap La Hêve, the ground gradually rises into a low cliff of some twenty-five or thirty feet high, capped by a thick deposit of red clay, sand, and angular flints, exactly in appearance resembling the ordinary flint-drift that covers the chalk-hills of England. This flint-drift is seen on the coast in considerable thickness, covering the irregular surface of the chalk, and filling up numbers of those extraordinary cavities so familiar under the name of sand-pipes. It appears to have come down or over the pretty valley of St. Addresse, covering the subjacent rocks of every description to the present sea-level. Near the limekiln by Perrey's mill, the low cliff referred to commences, and consists of about 10 feet of red, flint-gravel drift; gradually becoming higher, until near the sea-baths it has acquired an elevation of 30 or 40 feet. It is here that at the base of the cliff we perceive the sand to contain several bands of the semi-fossilized shells of species still living in the district, and in great abundance in the sands of the opposite coast at Honfleur, Trouville, and Dives. As the cliff increases in height, the beds of sand become of course more visible, and near the commencement of the road to St. Addresse, a most excellent section is presented, the measurement and description of which is subjoined:

Section of Gravel and underlying Sand at St. Addresse.

	ft.	in.
Vegetable soil	3 ?	0
GRAVEL—Red, sandy, flint-gravel, drift	10 ? ft. and upwards ?	
SAND DEPOSIT—Very friable, slightly adhesive, fine sand-rock, with lines of dark-green grains, and becoming slightly ferruginous at the base; crumbles in the hand	5	0
Band (more sandy than above) of shells of all ages and sizes, irregularly bedded, principally of *Cardium edule*	0	9
Parting of dark-green grains	0	1
Slightly adhesive sand-rock, as at top	0	3
Band of shells, irregularly bedded, principally of *Cardium edule*, *Mactra*, *Tellina*, becoming slightly ferruginous at the base	1	2
Parting with dark-green grains	0	3
Friable sand rock, containing band of great pebbles, some 4 in. square, with smaller pebbles and shells	0	4
Band of shells, irregularly bedded, *Cardium edule*, *Tellina*, etc.		
Band of small pebbles and comminuted shells	2	0
Resting on dark-blue argillaceous sand, intermixed at top with dark-grey sand	1	4
Grey argillaceous sand, semi-consolidated, containing at 28 in. from top a band of shells, *Cardium edule*, etc., with small univalves.		
Level of Beach.		

The shells found were principally those of the common cockle and Tellen, and these, though sometimes found in their normal position, were generally in the disorder and confusion so characteristic of littoral accumulations as to leave no doubt of the beds in question having formed at some former period a portion of the shore. The above-mentioned species of shells occurred in abundance, and no doubt a minute examination would add others to the list.

This portion of the section abuts against a great mass of *craie glauconeuse* and rubble, which almost seems to have parted the stream of flint-drift that surmounts the sand beds. The section from hence to the commencement of the cliffs of the Cape, consisting of a lofty sloping bank, is rendered extremely obscure by the vegetation which so luxuriantly covers it. There seems at places to be indications of sand, but whether the bed alluded to is continued, required more time and a more minute investigation than I had it in my power to bestow.

The existence of a bed of sand with recent shells below the flint-drift is a curious fact, if correct and I am not deceived by appearances. If correct, it should be of value in determining the comparatively modern origin of that great diluvial mass of angular flints, and the débris of the chalk, and of the Tertiaries, we find so extensively spread over the area of the Chalk.

If no error exists in my examination of the recent shell sand at Havre, the section there goes to show the recent origin of the "flint-drift," since not only the recent species of mollusks lived there, but even the configuration of the coast of Normandy must have had a near approximation to its present state before the drift gravel was deposited.

The undulating surface of the valley of the Seine must have approached nearly to its present line, although some differences either in the prevalent direction of the winds, or the outline of the shore, are required to account for the accumulation at that spot of so numerous a collection of shells, the mollusca and their débris being now on that side of the Seine, but sparingly distributed in consequence of the washing-away action of the boisterous seas, although such shells, as before stated, are abundant on the quieter shores of Honfleur, Trouville, and Dives.

If nothing more important be proved from this bed of sand, it must be admitted that an elevation of some feet has taken place in this district within a very restricted period. Of such an elevation we have also evidences on the English side of the Channel.

So like in mineral character is the flint-drift seen on the top of the cliffs of Cap La Hêve with that shown at the roadsides of the upper part of the valley of St. Addresse, that there seems no doubt of the continuity of the deposit over the shell-sand.

The mass of *craie* against which it abuts is not however *in situ.* The base of the cliffs of Cap La Hêve consists of marls, sands, and clays of the Gault, Greensand, Wealden? and Kimmeridge periods, by the rapid wearing away of which, the *craie glauconeuse* of which the upper portion of the cliff consists, is constantly falling or rather sliding down in enormous masses forming an extensive undercliff, as at Folkestone and the Isle of Wight in our own country. The direction of the dip shows that some of these beds would naturally be continued on the site of the "shell-sand," and this buttress of *craie* débris—for it consists of blocks and the regenerated material of several strata of the *craie glauconeuse,* as indicated by the mineral characters of the materials, the fossil shells, etc.—has slipped or been brought down from a higher level to its present position; and it is this which throws some doubt whether the flint-drift of our section may not have been brought down by landslips such as are now common at the Cape, and have been a portion of a former undercliff since cut into by the action of the sea. No fragments of shells, sand, or rock, indicating any amount of regeneration, are to be found in the "flint-drift," which consists entirely of ferruginous sand and angular pieces of flints, and which so far seems, allowing for local differences of mineralogical character, to be identical with the flint-drift so extensively distributed over this region. The next question to be determined, is how far back in geological history the species of shells found in the subjacent sand can be found to date their existence, because certainly the age of this shell-sand has to be mainly determined by its organisms, there being but little concurrent evidence as yet obtained from other sources than the mollusca found in the sand. The following are placed by Professor Forbes in his list of "species now living in British seas and found fossil in true glacial beds:"—*Mactra solida*, *Tellina solidula*, *Cardium edule*, *Nucula tenuis*, *Littorina littorea;* and *Mactra stultorum* is placed by the same author among the British species not found fossil in typical glacial beds, but occurring in contemporaneous Italian newer Pliocene strata.

The evidence therefore of the shells brings the age of this Havre sand between two limits, that of the Pleistocene on the one hand, and the Recent or Actual period on the other. The flint-drift, being superincumbent, must consequently take its place at a more recent stage than the sand within the same interval, if it be truly *in situ*.

The fossils of the recent shell-sand are well preserved, although extremely brittle, traces of colour being frequent, and the specimens of periwinkles, though not numerous, are hard, and but little changed in structure, excepting by the loss of albuminous matter. The portion of a tooth of *Elephas primigenius*, found on the shore in a mass of hardened sandy material near the termination of the valley of St. Addresse, and preserved in the cabinet of M. Flambard, indicates the existence and proximity of some Pleistocene deposit, the discovery of which would possibly throw much light on the position in time that our recent shell-sand ought to occupy. It would be highly interesting to determine the occurrence, and trace the connection of a freshwater marl or other deposit, containing bones of the Pleistocene mammalia, in this neighbourhood. In the drift exposed in the Cape cliff-section, there are evident signs of rude inclined stratification on the sides of the hollows and shorter sand-pipes of the chalk, and the inclination differs on either side, as we see to be the case with the ripples of sand which the strong current of a spring-tide makes on the seashore. We there see fragments of shells, or other comparatively large objects carried rapidly down the longer descending planes, and slowly up the sides of the steeper banks, and deposited beneath the crests of the waves. As the drifted shells render thus apparent to the eye the arrangement and disposition to which the grains of sand composing the bed of the shore are subjected, so by the disposition of the flints in the clays and sandbeds it seems to me we might interpret the directions and actions of the powerful flow that spread the drift over such extensive tracks of country. At least, whether we admit flood-action or not in the spread of the superficial deposits, a series of correct observations of such indications of the direction and arrangements of their contained pebbles and constituent materials would do much towards determining the direction of the current or force by which those materials were brought and deposited. The indications of drift-movement are generally, as far as I observed them, towards the north, but in some cases on the slopes of hills the course has evidently been southerly. The presence and form of the tongue of sand at St. Addresse seem to confirm the supposition that the flint-gravel overlying the "shell-sand" had a southerly tendency, which would be the case if it were continuous with the drift of St. Addresse and the high ground of Cap La Hêve. Further observations are, however, necessary to confirm this opinion.

The deposit of sand containing shells must have been originally very considerable, as the waste by the sea on this coast being very great, even on the harder rock of the cliffs, its action on such soft materials must have been highly destructive.

Since writing the above, I find in M. Passy's excellent description of the department of the Seine Inférieure, an account of this recent shell-sand, which that author considers to be a portion of the ancient embouchure of the Seine.

Passing from Havre westwards, I made collections of fossils at Honfleur, Dives, and all along the coast up to Caen, the quarries of which pour their rubble down the green wooded slopes of a lovely gorge into the river below,—the white city with its lofty houses and over-topping churches and cathedral, and the low Oolitic cliffs fringing the blue waters of the Channel in the distance, form an enchanting scene worthy of a longer pilgrimage than it takes to see.

From Caen I took the steamer back to Havre, and thence trudged along the shore by Fécamp and Dieppe to Boulogne. A sketch from my notebook at Etretât may well close this gossiping article. The needles and arches of our Isle of Wight are household words in the British geologist's mouth. So are the arches and needles of Etretât in every Frenchman's. Etretât was a fishing village. It was fast rising, when I was there, into a watering-place; it may boast by this time of handsome rows of marine residences, but it will not be more worthy of visiting than when it was as my pencil presents it to my readers in Plate IX.

ON THE OCCURRENCE OF ACANTHODES IN PALÆOZOIC ROCKS.

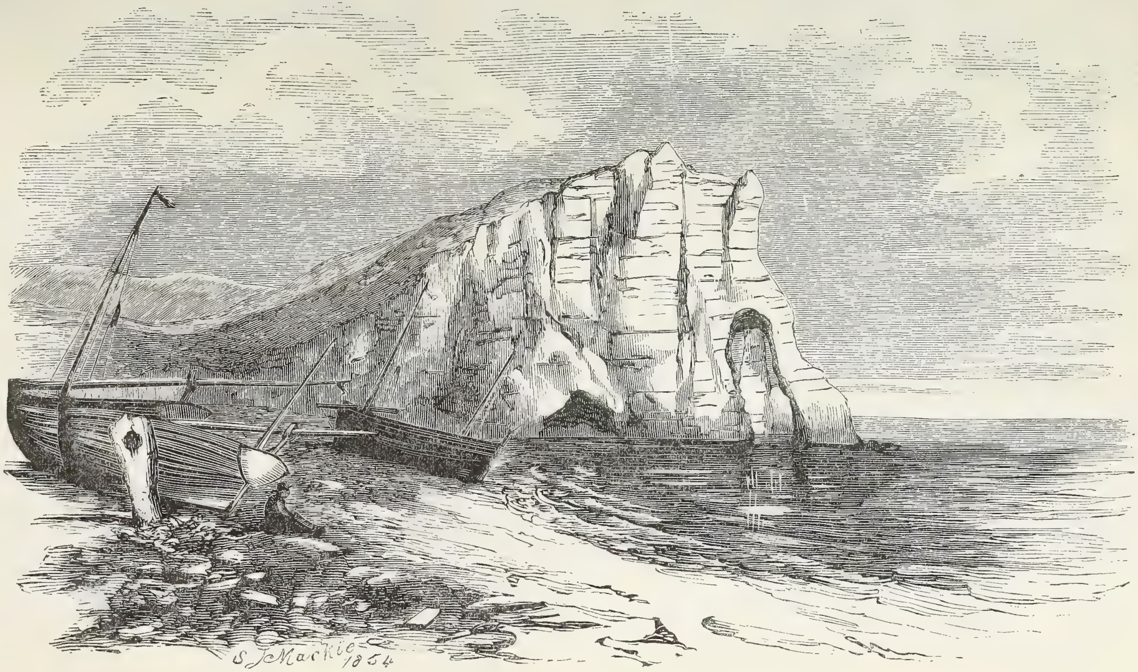
By Rev. Hugh Mitchell, M.A.

Whatever theory we may conceive or adopt respecting the origin of species, it is undeniable but that Acanthodes—a genus of fossil fishes—has maintained a noble struggle for life. Known to occur first of all in the Lower Devonian or Old Red Sandstone, it has been found also in the Middle Division of that great system, and again in the coal-measures, and finally disappears in the Lower Permian—the Roth-todt-liegende or Lower Dyas of German authors.

In the accompanying table we have endeavoured to put into accessible and readable shape the particulars of its occurrence, so far as known to us, among the rocks.

The Rocks.			The Species.	The Authorities.
Permian	Upper			
	Lower	*	Acanthodes gracilis, *Beyr*	Murchison, Journal of Geol. Soc. vol. xix. p. 303.
Carboniferous	Upper			
	Lower	* *	A. Brouni, *Ag.* A. sulcatus, *Ag.*	Egerton, Geol. Surv. Dec. 10, p. 57. Agassiz, P. F., p. 125.
Devonian	Upper			
	Middle	*	A. pusillus, *Ag.*	Agassiz, P. F., p. 301.
		*	A. Peachi, *Eg.*	Egerton, Geol. Surv. dec. 10, p. 57.
		*	A. coriaceus, *Eg.*	Egerton, Geol. Surv. dec. 10, p. 59.
	Lower	*	A. Mitchelli, *Eg.*	Egerton, Geol. Surv. dec. 10, p. 61.

We first detected the occurrence of Acanthodes in the Lower Devonian or Old Red Sandstone at Farnell, in the county of Forfar,



CHALK ARCH AND NEEDLE AT ETRÊTAT, NORTH COAST OF FRANCE.

Scotland, in the summer of the year 1857. From investigations since made, it now appears that an abundant flush of Acanthodian life ushered in the morning of the vast period embraced by the Old Red Sandstone. Along with the genus Acanthodes there occur also several other genera of the Acanthodian family, such as Climatius, Parescus, and some unnamed. The genera Climatius and Parescus were first founded upon and described by Agassiz, in his great work, from spines, but since the perfect forms have turned up in our northern rocks, it has been found necessary to remove them from among the Cestraciont Placoids into the Acanthodian family of the Ganoids, that is to say, provided we adhere to the classification of Agassiz. Other genera and species occurring with us remain to be described, and we are very much disposed to think that the spines figured from the Ludlow bone-bed in the Upper Silurian must be relegated to Acanthodian forms. Much as has been made of it, have we any evidence of the occurrence of Placoidal fishes in those rocks at all, except pieces of shagreen-looking skin? What if these, on closer scrutiny, turn out to be Crustacean and not Piscine remains? Would it not be worth the while of some of the earnest observers in that region to examine carefully those Ludlow beds, or especially their equivalents, where spines occur, for the complete forms? It was long thought that in our Scottish rocks of the Lower Devonian we had nothing but unattached spines of these fossil fishes.

It may be observed, in order to remove all doubt of the position here assigned to the beds of the Old Red Sandstone in which Acanthodes first occurs, that we have specimens on the same slabs with plates of the Pterygotus, and in the same stone with *Cephalaspis Lyellii.* It may be that other species of Acanthodes occur in our Lower, but it is certain that in the Middle beds of the Old Red, as they occur in Moray and Caithness, there is a fuller development of species. But in such a feature the genus would resemble many others in the geological muster-roll of being,—presenting us first with a weak dawn,—then culminating into meridian fulness, but again sinking into a slow decline and final extinction, yet still preserving throughout the career of their existence the characteristic traits of their generic life, the dying representative of the genus is not however a degraded form, but is as beautiful and as highly a developed creature as its first introduced ally. The outline of the body of the Acanthodes of the Lower Devonian Egerton describes as remarkably graceful, and Römer has given the specific appellation of *gracilis* to the Acanthodes of the Lower Permian,

It is certainly worthy of remark that the genus Acanthodes is persistent through such a lengthened period of geological existence; and from such a circumstance we are inclined to infer that as the details of the stony record are filled up, all gaps will disappear. We do not and cannot admit the truth of the theory of the transmutation of species, yet the course of creation has not proceeded by sudden bounds, but by a steady, calm advance. There is no evidence, so far as proof has been adduced, of the development of one good natural species into another; but there is evidence of a development of plan, and that development is but revealed to us in the occurrence, in these ancient life-periods, in succession of similar or kindred forms. Ever as the circumstances of their life are becoming alike, the species necessarily approach and resemble.

The history of Acanthodes, thus brought before us, almost warrants these conclusions:—First, there are no gaps, either in the succession of strata or in the course of creation, at least over lengthened periods, embracing it may be several so-called geological systems. A narrow horizon may indeed give the idea of wreck, but when the horizon of our observation is broadened, the chasms disappear. Secondly, there is evidence, at least in Acanthodes, there is no symptom of one true and good natural species developing into another, particularly not into a higher or advanced form. Thirdly, nor is there, as has been contended for by some writers, a degradation, either in size or in beauty, and other features of form, among species of the same genus, whose existence stretches over a long period. Fourthly. What however may be called digression or even retrogression of form appears in the development of the scheme of an Organized Creation. There is digression or departure from the type to put on some specific character towards an adaptation to some new circumstance in the life of the species; and again there is retrogression, a throwing off again of the specific or induced characteristic, and a return to the primitive or naked type. The mould in which the life is cast is not broken, but enlarged; yet after being enlarged, it is often again contracted ere the genus disappears in the onward current of the ages.

It is matter of regret with us now that when Egerton described in the decade of the Geological Survey the species of Acanthodes from the Lower Devonian, all our materials were not put into his hands. Distance is a sufficient excuse, but it is necessary to supplement his description by one or two remarks. The species occurs of a very small size. We have a specimen, scarce half an inch in length, a very minim of creation, but a perfect portrait in itself, with its every spine and every scale in their place. When well preserved, the scale appears to be perfectly smooth, and not ornamented in the least. And in many specimens there is a display of several small spines between the pectorals and the ventrals, as if the creature had an undercrop of rudimentary fins, which were attached to the spines, for the propulsion of its graceful and slim figure through the waters, and for its escape from its many enemies. The species occurs in our Old Red beds over almost the whole county of Forfar, and in the neighbouring county of Kincardine, and should be looked for in the equivalent beds of England.

ON THE FOSSIL FORAMINIFERA OF MALTA AND GOZO.

By Professor T. Rupert Jones, F.G.S.

In a former volume of the 'Geologist' there are notices of the geology of Malta and Gozo (vol. for 1860, pp. 198, 275, 421), from which it appears that the stratal groups forming these islands are, in downward succession,—

1. Upper Limestone; fossiliferous.
2. Soft sandy rock, consisting of yellow, green, and black sand in variable proportions, and containing many shells and echinoderms, chiefly as casts, and sharks' teeth.
3. Bluish marl, with sharks' teeth and other fossils, especially *Pecten Burdigalensis.*
4. Light-yellow calcareous freestone; the common building-stone of the islands, rich with echinoderms, and containing also nautilus, fish-remains, and other fossils: this comprises also a band of chocolate-coloured pebbles, with sharks' teeth.
5. Lower Limestone, white and hard; with *Scutella subrotunda,* fish-teeth, and a few other fossils.

These strata have been described by Captain Spratt, in the Geol. Soc. Proc., vol. iv. p. 225, etc., and their fossils determined and enumerated by Professor E. Forbes, *ib.*, p. 230, etc. Dr. Wright also gave a notice of the beds, and descriptions of several of their fossils, in a paper published by the Cotteswold Nat. Field-club, and in the Annals Nat. Hist., 2nd ser., vol. xv.; lastly, Dr. A. L. Adams and Dr. Wright communicated a paper on the Maltese Strata and Echinoderms to the Geological Society, in 1863.

Having lately received, from Captain F. W. Hutton and Dr. A. Leith Adams, some fine specimens of foraminifera from the Maltese beds, carefully labelled as to their respective strata, as well as some notes on the strata from the same friends, I am enabled to add something as to the distribution of the foraminifera.

Stratum No. 1, which, being largely composed of corallines (Nulliporæ, E. Forbes's List, *loc. cit.*), and destitute of corals, seems to have no title to its old name of "Coral-limestone," contains *Heterostegina depressa,* according to Dr. Adams and Captain Hutton; the latter informs me that this limestone is sometimes 230 feet thick, *Pecten Pandora* being one of its most abundant fossils.

Stratum No. 2, varying from 1 to 30 feet in thickness, is in many parts composed almost entirely of the little flat foraminifer that was formerly mistaken for a nummulite and a lenticulite, but is really *Heterostegina depressa.* The specimens of this bed (from Dingli, Malta, where it is 30 feet thick), with which I have been favoured by Captain Hutton, are dark-yellow friable shell-rock or limestone, consisting of Heterosteginæ massed together in every position, mixed with a few valves of Pecten, in a scanty granular calcareous matrix, with calcareous cement. Many of the grains are obscure foraminifera and débris of shells, etc. Mr. Parker has detected the following foraminifera in this matrix :—*Globigerina bulloides*, *Truncatulina lobatula*, *Planorbulina ammonoides* (Quart. Journ. Geol. Soc., vol. xvi. p. 300), and *Calcarina rarispina*.

Dr. Carpenter's allusion to this Heterostegina-rock as being found *in fissures* in Malta, appears to be incorrect (Introd. Foraminif. Ray Soc., 1862, p. 288).

In some places this bed contains a large quantity of green grains. These may prove, on examination by the microscope, to be casts of the cells of foraminifera, bryozoa, etc., as Bailey and Ehrenberg have shown other sands of silicate of iron really to be. Captain Spratt and Professor E. Forbes (*loc. cit.*) notice the occurrence of cetacean bones in this bed, and of oysters with the Heterosteginæ.

The bed No. 3, blue marl, about 100 feet thick, is not yet known to contain foraminifera; but should be examined with careful manipulation, as described in the 'Geologist,' vol. ii. p. 244.

No. 4, the freestone, consists of four or five divisions that run one into the other, lying in no regular order. The building-stone is that in which most of the Echinodermata are found. Captain Hutton and Dr. Adams state that the Heterostegina occurs in the freestone; the latter points out that it is much rarer than in No. 2, "and only in a drab or light-blue portion towards the upper parts of the bed." In Professor E. Forbes's list (*op. cit.* p. 230), Cristellaria and Nodosaria are said to occur in the upper division of this freestone; and within the last few days Captain Spratt has obligingly shown me the specimens referred to. They comprise *Nodosaria Raphanus*, *N. Raphanistrum*, *N. Radicula*, *Dentalina acicula*, *D. pauperata*, *Lingulina costata*, *Frondicularia annularis*, *Cristellaria calcar*, and *C. cassis*. No doubt numerous smaller forms will also be found; for these are the larger specimens of such a group of foraminifera as D'Orbigny has figured and described in his Foram. Foss. Bassin. Tert. de Vienne. Some of the specimens are yellowish, some are greyish, indicating at least two beds or seams that are rich with them.

No. 5 is the hard whitish limestone, also used for building; it is very variable in lithological character, Captain Hutton says, and more than 400 feet thick; he adds, that "it is at the top of this bed only that *Scutella subrotunda* is found." I find, by specimens that have been shown to me, that it also contains, in large abundance, *Operculina complanata* and *Orbitoides dispansus*.

The Operculinæ (which appear to be two subvarieties) occur gregariously in the upper part of the limestone, are associated with *Scutella subrotunda* and *Echinolampas scutiformis*, and "are very common at the fault at Migiar Selimi in Gozo, and at various points along the northern coast of Malta." (Dr. A. L. Adams.) A large hand-specimen that Captain Hutton has kindly given me, comes from Marsa Scala, Malta.

[We must remember that the so-called "*Lenticulites complanatus*" (an old name of *Operculina complanata*), of Professor Forbes in the Proc. Geol. Soc., *loc. cit.*, and of Dr. Wright in the Annals Nat. Hist., 2nd ser., vol. xv. p. 101, etc., is really the *Heterostegina depressa*, as the Maltese specimens in the Museum of the Geological Society show. See also Quart. Journ. Geol. Soc., vol. xvi. p. 300, *note.*]

Of the Orbitoides, Dr. Adams writes,—"They are characteristic of the point of transition between the Lower Limestone and the Calcareous Sandstone; indeed, I have seen them nowhere else. They are so abundant that whole masses of limestone seem to be entirely composed of them; properly speaking, they are fossils of the Lower Limestone, and are frequently associated with what you name *Operculina complanata*, which seems, as far as I can find out, also peculiar to the same situations." The only locality that Captain Hutton knows for the Orbitoides-rock "is just south of Fort Ricasoli."

Captain Hutton believes that he has detected foraminifera in thin slices of some of the hard white limestone (made up of more or less rolled calcareous débris) from St. George's Bay, Malta.

Obituary Notice.

THE REV. DR. ANDERSON,

OF NEWBURGH.

There is a solemn pleasure in paying a last tribute to those who have been our friends, and those we have respected. Death draws the dark veil between the living and the past away, and when one worker is taken away from the grand field in which we are labouring, the last act of kindliness to the departed those who are left can contribute is the record of the worth of the departed. Amongst the fossils of Dura Den, the Minister of Newburgh was a great and successful worker, as the fine slabs of fish in our museums, and some of the best plates in Agassiz's memorable 'Poissons Fossiles,' and in his 'Grès rouge d'Écosse' substantially testify. As a writer on geological subjects, Dr. Anderson will not take rank in highest eminence, but for the work he has done in his locality, he will stand in position with the best of our local-workers. The Edinburgh 'Evening Courant' of the 18th ult. gives a very nice notice of one that all who knew respected for his fine personal qualities.

The geological works published by Dr. Anderson were,—'On the Remains of Man in the Superficial Drift,' 'The Course of Creation,' 'The Geology of Fifeshire,' "The Geology of Scotland," in the Rev. Dr. Taylor's 'History of Scotland,' and 'Dura Den,' a monograph of that remarkable fossiliferous locality. Dr. Anderson, too, took a lively interest in the local affairs of his district, and in the antiquities of his parish. He was also the promoter of a motion in the General Assembly of 1860, for making the study of natural science compulsory on students of the Established Church. The testimony paid to his individual worth by the writer in the Edinburgh paper referred to, will find a ready response in the hearts of all who knew him.

CORRESPONDENCE.

Restoration of Pteraspis.

My dear Sir,—I should like, with your permission, to make a remark upon the Rev. Hugh Mitchell's interesting letter and sketch of Pteraspis. It seems to me that the specimen there sketched agrees with Professor Huxley's restoration (given in a former letter) in all particulars, saving the absence of lateral cornua, the form of the terminal angles, and the presence of the two large apertures which Mr. Mitchell has drawn in his letter. These differences are, I think, to be accounted for by the imperfect condition of Mr. Mitchell's specimen. I have seen some hundred specimens of Pteraspis with the lateral cornua and with no posterior apertures, but in every point agreeing with Professor Huxley's restoration. I have also seen some hundreds of specimens in a fragmentary condition, showing *no* cornua, no spine, no rostrum, and often showing apertures in the test, caused by fracture; but most palæontologists will, I think, agree with me in considering the more perfect specimens as indicating the true form of the shield of Pteraspis, and will attach no weight to the negative evidence of imperfect specimens. The restorations of Pteraspis given by Mr. Mitchell in May last, differ as much from the present one as it does from Professor Huxley's. In the former restoration there was no rostrum and no spine; but the discovery of fresh specimens has shown that the Scottish Pteraspides did possess spines and rostra like their English brethren. No doubt a little time will suffice to show that they also possessed lateral cornua and a form of the central disk, in nowise differing from that of the English specimens.

With regard to the under surface of the head of Pteraspis, even the great abundance of specimens in Herefordshire has afforded no evidence, save that of a negative character, and it seems to be a fair conclusion that it was unprotected; the mouth being placed as in the sturgeon, and perhaps of the same suctorial character. I may observe here, that in August last I obtained the first specimen of the scales of Pteraspis, from a quarry in Herefordshire. They are similar to those of the dorsal series of Cephalaspis, and are attached to a portion of the cephalic shield.*

Truly yours,
E. Ray Lankester.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Civil Engineers.—*January* 26.—"On the East Coast between the Thames and the Wash Estuaries." By Mr. J. B. Redman, C.E.—The object of this paper, like that of 1852 on the South Coast, was to describe the characteristics of a range of coast within certain limits, to trace the changes produced by constant natural causes, and the resultant influences on the various harbours; those of Harwich, Orford, Southwold, Yarmouth, Blakeney, Wells, and Brancaster being mainly dependent on such natural barriers as those described; as also their improvement, or deterioration, which in some instances, as at Yarmouth, by judiciously constructed works, material improvement was effected, and as at Orford, where no assistance was rendered, great changes occurred, or as at Harwich, where, from constant progressive change, it was difficult to speculate on the ultimate result of the continued operation of natural agencies, unchecked by works of a conservative character.

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* A communication on the discovery of these scales has been addressed to the Geological Society.

Geological Society.—*Jan.* 20.—1. "Observations on supposed Glacial Drift in the Labrador Peninsula, Western Canada, and on the South Branch of the Saskatchewan." By Professor H. Y. Hind, Trinity College, Toronto.—During an exploration of a part of the interior of the Labrador peninsula, in 1861, the author had an opportunity of observing the magnitude, distribution, and extraordinary number of the boulders on the flanks of the tableland of that area; and he commenced this paper with a detailed account of the results of his observations, referring also to the forced arrangement of blocks of limestone, shale, and Laurentian rocks in Boulder-clay at Toronto, and on the south branch of the Saskatchewan. Professor Hind then described briefly the Driftless Area, in Wisconsin, discovered by Prof. J. D. Whitney, and the conclusions to which that geologist has been led by the study of this district. He next adverted to the beaches and terraces about the great lakes, and considered their origin to be similar to that suggested by Mr. Jamieson for the Parallel Roads of Glen Roy. The formation of anchor-ice in the Gulf of St. Lawrence, and at the heads of rapids in the great river itself, was alluded to as one of the means by which river-beds may be excavated. The parallelism of escarpments in America, at great distances apart, and at elevations varying from 600 feet to 3000 feet above the sea, was next described, and their symmetrical arrangement suggested to be the result of glacial rivers undermining the soft strata of sedimentary rocks in advance of the glacial mass itself. These escarpments were also thought to represent different and closely-succeeding glacial epochs.

2. "Notes on the Drift-deposits of the Valley of the Severn, in the neighbourhood of Coalbrookdale and Bridgenorth." By Mr. George Maw.—The patches of drift occurring in the Valley of the Severn from about four miles below Bridgenorth up to Shrewsbury, including a north and south range of about twenty miles, have been carefully examined by the author, and were described in detail in this paper. Commencing with Strethill, a hill close to the entrance of Coalbrookdale, the author described the several beds which make up the drift-deposits of which it is composed, and gave a list of the rocks which he had found in them. In the same manner he described in succession the neighbouring districts in which the drift-deposits are exhibited, and gave a list of the fossils which had been found in the beds at the different localities. In conclusion, Mr. Maw put forward some hypotheses as to the period when the degradation of the older formations (the materials of which compose the Drift) took place, the manner in which the Drift was deposited, the extent of the submergence of England and Wales during the period of its deposition, and the influence of glaciers and glacier-action in its production.

February 3.—1. "On the Permian Rocks of the North-West of England, and their Extension into Scotland." By Sir R. I. Murchison and Prof. Harkness.—In this paper the authors propounded a new view of the composition of the Permian Group in the north-west of England; by rearrangement of the rocks involved in this change in classification, they were enabled to place the Permian strata of Great Britain in direct correlation with those of the Continent. This new feature in British classification is the assignment of a large amount of Red Sandstone in the north-western counties to the Permian period, and its removal from the New Red Sandstone, or Trias formation, to which it has hitherto been assigned in all geological maps. The authors showed that these Red Sandstones are closely and conformably united with the Magnesian Limestone or its equivalent, and form the natural upper limit of the Palæozoic deposits. They thus affirmed that a tripartite arrangement of the Permian rocks holds good in Westmoreland, Cumberland, and Lancashire, and that the three subdivisions are correlative with those formerly shown by Sir R. I. Murchison to exist in the Permian deposits of Germany and Russia; thus proving the inapplicability of the term Dyas to this group of rocks.

The difference, in lithological details, of the Permian rocks of the north-west of England from those on the opposite flank of the Pennine chain, was next adverted to; and it was observed that, with so vast a dissimilarity in their lithological development in England, we need not be surprised at finding still greater diversities in Germany and Russia.

The discovery, by Professor Harkness, in the central member of this siliceous group in Westmoreland, of numerous fossil plants identical with the species of the Kupfer Schiefer in Germany, and in the Marl-slate of the Magnesian Limestone of Durham, was given as a strong proof of the correctness of the author's conclusions.

The comparative scarcity of igneous rocks, and the evidence of powerful chemical action in the Permian strata of Britain, is contrasted with their abundance in deposits of that age in Germany; but proofs are nevertheless brought forward to show that the hæmatite of Cumberland and Lancashire was formed in the early accumulation of the Permian deposits.

In describing in detail the different members of the Permian group of the north-west of England, the authors define the downward and upward limit of the strata which have undergone dolomitization; for whilst certain bands of calcareous breccia (the "brockrum" of the natives), which occur in the central portion of the series, contain much magnesia, the lower breccias, composed of the same mountain-limestone fragments, have no trace of it; nor is it to be detected in the Upper Member, or St. Bees Sandstone.

A large collection of rocks and fossils from Victoria, Australia, presented to the Society by A. R. Selwyn, Esq., was exhibited.

February 19.—Annual General Meeting. Prof. A. C. Ramsay, F.R.S., President, in the chair.—The Secretary read the Reports of the Council of the Museum and Library Committee. The increase in the numbers of the Society, and the state of the Society's finances, were considered to be extremely satisfactory. The President announced the award of the Wollaston Gold Medal to Sir Roderick Impey Murchison, K.C.B., etc., for his many distinguished services to palæozoic geology, especially (1) for his great work entitled the 'Silurian System;' (2) for his important work 'On the Geology of Russia;' and (3) for his remarkable discovery of the true relations of all the rocks beneath the Old Red Sandstone that form the Highlands of Scotland; and, in handing the medal to the eminent recipient, he took occasion to review briefly the influence of these various labours on the progress of geological science. Sir Roderick Murchison, on receiving the medal, expressed his deep sense of the honour which had been done him by the Society, and which was enhanced by its being communicated to him through his friend and colleague Professor Ramsay. The President then stated that the balance of the proceeds of the Wollaston Donation Fund had been awarded to M. Deshayes, to assist him in his work on the Mollusca of the Paris Basin, and in testimony of the high esteem in which the Geological Society hold those labours, and placed it, together with a diploma to that effect, in the hands of the Foreign Secretary, for transmission to M. Deshayes. Dr. Falconer thanked the Society on behalf of his distinguished friend, and stated that he should have much pleasure in conveying to him this mark of the Society's approbation.

The President then proceeded to read his Anniversary Address, prefacing it with biographical notices of lately deceased Fellows of the Society, namely, Lucas Barrett, Esq., the Marquis of Lansdowne, John Taylor, Esq., Professor E. Mitscherlich, and S. P. Pratt, Esq.; he also gave a sketch of the chief labours of the late Rev. Stephen Hislop. In the address, the President discussed the breaks in succession of the British mesozoic strata; thus endeavouring to discover how far, and in what manner, the same kind of reasoning as that employed in the last address is applicable to Secondary formations. First, however, he examined the numerical relations which different classes of animals bore to one another in palæozoic times, comparing them with their development in Secondary epochs. The general conclusion arrived at was, that a long interval of time, often stratigraphically unrepresented, is an invariable accompaniment of a break in the succession of species; and the more special inference was that, in cases of superposition, in proportion as the species are more or less continuous,—that is to say, as the break in life is partial or complete, first in the species, but more importantly in the loss of old and the appearance of new genera, so was the interval of time shorter or longer that elapsed between the close of the lower and the commencement of the upper formation.

The ballot for the Council and officers was taken, and the following were duly elected for the ensuing year:—*President:* W. J. Hamilton, Esq., F.R.S. *Vice-Presidents:* R. A. C. Godwin-Austen, Esq., F.R.S.; Edward Meryon, M.D.; J. Carrick Moore, Esq., F.R.S.; Sir R. I. Murchison, K.C.B., F.R.S. *Secretaries:* P. Martin Duncan, M.B.; Warington W. Smyth, Esq., M.A., F.R.S. *Foreign Secretary:* Hugh Falconer, M.D., F.R.S. *Treasurer:* Joseph Prestwich, Esq., F.R.S. *Council:* John J. Bigsby, M.D.; Robert Chambers, Esq., F.R.S.E. & L.S.; P. Martin Duncan, M.B.; Robert Etheridge, Esq.; John Evans, Esq., F.S.A.; Rev. Robert Everest; Hugh Falconer, M.D., F.R.S.; R. A. C. Godwin-Austen, Esq., F.R.S.; William John Hamilton, Esq., F.R.S.; J. Gwyn Jeffreys, Esq.; M. Auguste Laugel; Sir Charles Lyell, F.R.S. & L.S.; Robert Mallet, Esq., C.E., F.R.S.; Edward Meryon, M.D.; John Carrick Moore, Esq., F.R.S.; Professor John Morris; Sir R. I. Murchison, K.C.B., F.R.S.; Joseph Prestwich, Esq., F.R.S.; Professor A. C. Ramsay, F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; Alfred Tylor, Esq., F.L.S.; Rev. Thomas Wiltshire, M.A.; S. P. Woodward, Esq.

February 24.—1. "On further Discoveries of Flint Implements and Fossil Mammalia." By Mr. J. Wyatt, of Bedford.

The opening of a section at Summerhouse Hill gave the author an opportunity of ascertaining whether the gravels at that Lower Level exhibited any features different from those of the Upper Level at Biddenham. Although, as might have been expected, some of the species of mammals were found to be common to the two localities, yet that under notice furnished some species of mammals, as well as of shells, together with a few types of flint implements, differing from those met with at higher levels. Mr. Wyatt described the section at Summerhouse Hill in detail, showing that it tended to support Mr. Prestwich's opinions respecting the formation of gravel-beds; he also described the flint implements he had recently found, comparing them with known specimens from the Valley of the

Somme and elsewhere; and he stated that he was now enabled to add two new localities near Bedford—Summerhouse Hill and Honey Hill—to those already known as having furnished similar weapons.

2. "On some Recent Discoveries of Flint Implements in Drift Deposits in Hants and Wilts." By Mr. John Evans.

Flint implements having recently been found on the seashore, about midway between Southampton and Gosport, by Mr. James Brown, of Salisbury, and also at Fisherton, near Salisbury, by Dr. H. P. Blackmore, of that place,* the author visited these localities in company with Mr. Prestwich, and gave the results of his observations in this paper.

After describing the implements from near Southampton, and having shown that their condition is identical with that of the materials composing the gravel capping the adjacent cliff, Mr. Evans proceeded to review the evidence of the great antiquity of these remains, which rested mainly on the circumstance that these gravel-beds, like those of Reculver, are of fluviatile origin, although now abutting on the sea.

In like manner the author then described the Fisherton implements, and the gravel-pits from which they were obtained. The relation of the high-level gravels (in which the implements were found) to the lower-level gravels of the valley of the Avon was next discussed, and the geological features of the former deposits particularly described, lists of the fossils (including mammalia and land and freshwater shells) being also given. Mr. Evans came to the conclusion that the fossils bore evidence of the climate, at the time when they were deposited, having been more rigorous, at any rate in the winter, than it now is; and to this cause he attributed the comparatively greater excavating power of the early Postpliocene rivers.

MANCHESTER PHILOSOPHICAL SOCIETY.—*January* 12, 1864.—The President, Mr. Binney, made some remarks on the Lancashire and Cheshire Drift. In the year 1841 he first attempted to class the drift-deposits found in the neighbourhood of Manchester, in a small paper with a map, which he prepared for the Statistical Society of Manchester. In that memoir he divided the foreign drift in the ascending order:—(1) Lower sand and gravel; (2) till; (3) upper sand and gravel; and he described the more modern deposits found in valleys; (4) as valley gravel. This order he adopted in a paper read before the Manchester Geological Society on the 22nd December, 1842, "Notes on the Lancashire and Cheshire Drift," and printed by that Society in their Proceedings of 1843. In that paper, in treating of the upper beds of sand and gravel, he says, "At Manchester, it (the higher drift) is composed of lower gravel, till, and sand and gravel; while at Heywood and Poynton, near the base of the Pennine chain, the beds of sand and gravel are parted by several beds of loam and clay." Again, in speaking of No. 3 deposit, he says, "The gently-rising lands of the two counties are generally composed of this deposit. It varies much both in its composition and thickness. Near the sea at Ormskirk, the till is sometimes found without it; but as you proceed to the east it makes its appearance, and gradually thickens until it attains its greatest thickness near the base of the Pennine chain: not only does it increase in thickness. but it becomes more complex, and contains beds of clay, marl, and loam of several yards in thickness. The country lying between Manchester, Bolton, Bury, Rochdale, Ashton, and Stockport, for the most part is upon it, and forms one great sandbank, which continues south into Cheshire." The same classification he adopted in two papers—one on the Drift of Manchester, and the other on the same deposits at Blackpool—printed in vols. viii. and x. of the Society's Memoirs, as well as in a paper printed in the Manchester Geological Society's Transactions for June, 1862.

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* This discovery has been recorded already in the 'Geologist,' and we trust the acknowledgment will be duly made in the Quarterly Journal of the Society.

Mr. Hull, in his communication, read at the last meeting of the Society, divided the higher drift deposits into (in descending order):—"(1) Upper Boulder Clay; (2) Middle Sand and Gravel; and (3) Lower Boulder Clay. The Nos. 2 and 3 had been described by the President as also a lower bed of sand and gravel, of whose existence he (Mr. Hull) had considerable doubts, and considered it as merely accidental." Now, in his (the President's) paper on the Drift of Manchester, eleven sections of wells and bores are given, and in ten of those the lower sand and gravel had been met with; thus showing that it can scarcely be considered as merely accidental, as Mr. Hull states. In many other sections since examined in Lancashire, this deposit has also been found under the till. With regard to the upper bed of boulder clay, to which the President had alluded, Mr. Hull considered it to be quite as important as the lower, both in thickness and area.

The old term "till" is as good as that of boulder clay, and as it has been long used there is not much use in changing it. During the last twenty years he had collected many facts, which he intended to publish when he had completed his collection, but these did not show one bed of clay or marl which could be called upper boulder clay, but several; in fact, there were numerous intercalations of it in the sand and gravel, one of which he had seen occurring at Kersall Moor, entirely surrounded by sand. To show the complexity of these deposits, and the difficulty of reducing them to two, he gave two sections, one near Hyde and the other at Outwood, where the following strata were met with:—

HYDE.

	Feet	in.
Clay	11	0
Quicksand	2	6
Strong marl	22	6
Quicksand	2	6
Loam with pebbles	12	6
Buck leaf marl	19	0
Dry sand	9	0
Quicksand and loam	6	0
Gravel	3	0
Loam	7	6
Gravel and sand	3	0
Clay and loam	15	6
Gravel and soft metal containing pebbles	10	0
Coal-measures		
	124	0

OUTWOOD.

	Feet	in.
Bog	11	0
Quicksand	53	3
Buck leaf marl	31	2
Red sand and gravel with a yard of clay in it	15	0
Toad-back marl	32	3
Gravel	3	0
Coal-measures		
	145	8

From the position of the Outwood section in a slight depression, and the higher grounds adjoining being capped with a bed of clay containing pebbles eight or ten feet in thickness, another deposit of clay should be placed on its top. Thus, in one case there are six beds of boulder clay, and in the other only three. These are two of the many instances which could be adduced, and suggest caution in attempting to classify these deposits without collecting and consulting numerous sections.

Manchester Geological Society.—*January* 19.—Mr. Dickinson, one of her Majesty's Inspectors of Mines, read a paper on "Modern and

Scriptural Geology." He had for many years endeavoured to reconcile the commonly-received geological theories with the Scriptural account of the creation of the world, and it was only after repeatedly returning to the subject that he had come to a simple view, which he believed was alike in accordance with observed facts and Scriptural record. He considered that the modern theories as to the formation of the earth involved many improbabilities. With the exception of pumice-stone, which might be produced by the local spontaneous combustion of some of the productions of the earth, occasioned by heat, friction, or chemical change, all things appeared to have originally been in a watery state. Even now rocks were so moist that a current of air driven through them at once became saturated; and the soft moist nature of rocks was further proved by the striations which were exhibited wherever the continuity of rocks had been dislocated. There were no remains of surfaces like that which covered now the earth; no beds of rivers; and as to the so-called denudation, rocks thousands of feet, nay, even miles in depth, would be wanting to account for the present alluvial deposit. Immense blocks of the denuded rocks would have remained. The pebbles and boulders were insufficient to account for what had disappeared; besides, a striking relationship existed between the pebbles and the underlying and adjacent strata. These pebbles, he believed, did not drift by glaciers, but were formed on the spot. The Scriptural account of the creation led him to suppose that water was the first element; that following the creation of light, which was the first day's work, expansion commenced; force had thus begun, and with the light apparently came chemical action, electricity, magnetism, heat, motion, and the like. Parts aggregated and repelled, until what we call the firmament was made. The waters then divided, part went above, and part went below, the latter being called the earth. Scripture also told them that every plant of the field and herb of the earth was in the earth before it grew, and this would account for fossil remains in whatever part of the structure of the earth they might be found. He considered that the earth was now in the same state as it existed after the dividing of the waters, and the striations on surface-rocks were the result of ordinary friction when in a soft state, when the waters divided. When the earth was cut into, there was a freshness about it which showed that it had seldom been disturbed in prehistoric times, and which refuted the notion that the world was any older than the period assigned by Scripture. The paper did not meet with a very flattering reception, but the author "knew of old what it was to express sentiments that were contrary to those commonly received as the fashion of the day."

Geological Society of Dublin.—*Jan.* 13.—Professor J. B. Jukes, F.R.S., in the chair. 1. "An Attempt to calculate the Duration of Time involved in Geological Epochs." By the Rev. Professor Haughton.—Geologists having got into the habit of speaking of long periods of time with extreme vagueness, he thought it a point of interest to consider how long animals could have existed on the globe. If we admit that the earth has cooled down from a gaseous condition to its present solid consistence, it is evident that organic beings could not have existed on the earth until it assumed some degree of solidity. Most geologists were acquainted with the ingenious proof, which we owe to Arago, that the earth has not cooled half a degree (Fahrenheit) since the time of Joseph. His proof is founded on the fact of Joseph's having received from Jacob, in the present sent to him to Egypt, some fruit which still grows in Palestine, and which will not bear a climate differing in any way from that of Palestine at the present day. Hence we see that the earth is only losing heat very slowly now. Professor Bischoff, of Bonn, made some experiments on the rate of cooling of basalt, and on these Professor Helmholtz had founded a calculation, by means of which he proved that the period which a globe of basalt of the size of the earth would take to cool from 2000° C. to 200° C. would be 350,000,000 of years. This calculation he would assume; and, as the extreme limits of temperature to which his reasoning would apply, he would take 122° F. and 77° F. The first is the temperature at which albumen coagulates, and therefore no animal could live at that temperature, as its blood would be coagulated. As the lower limit he would take the temperature of 77° F., which had been admitted to have been the probable temperature of these islands at the time of deposition of the London clay, Professor Heer, of Zurich, had lately expressed his opinion that the temperature of Switzerland during the Miocene epoch was between 67° and 72°, and that period was subsequent to the London clay. Assuming these limits, and the period above-named (350,000,000 years), as his data, he found that the earth, if it be supposed to be made of basalt, would require 1,280,000,000 years to cool through the required space. This reasoning was based on the well-known law of cooling of a heated body; and it was obvious to every one that the second period must be much longer than the first one, as the hotter a body is the faster it will cool. In this period we have space enough for the wildest phantasies of geologists. Professor Haughton did not conceive that changes of climate, produced by alteration in the relative positions of land and water, could account for the facts discovered by Sir L. M'Clintock about the fossils of the Arctic regions, nor did he now believe that the axis of the earth had changed its position.

2. "On the recent Discovery of Bones of the Polar Bear in Lough Gur, county Limerick; with Observations on their Comparison with Bones of the Cave Bear, in the collection of the Earl of Inniskillen." By Dr. Carte.—The locality whence the specimen was derived was a very famous one for such remains. The lake was remarkable for being supplied from springs, as there was no stream flowing into it; and as there were caves in the district, and throughout the whole country from that to Mitchelstown, it might perhaps be found that the lake was the site of an old flat-roofed cave, and that the animals whose bones were found there, and which belonged to the ordinary cave species, had lived in the district. They could not have been brought by drift, as the country was quite free from that deposit. It appears that the margin of the lake is studded with stone circles and other structures of antiquarian interest. The bones are found round an island in the lake, called Ganet Island, in shallow water. The whole lake is shallow, and has been much reduced in depth during the last few years by being drained by an artificial cut. The country people had raised several tons of bones, and sold them as manure. They consisted of a very heterogeneous assemblage of animals, such as deer, pigs, horses, cows, dogs, goats, sheep, etc., with stone celts, and fragments of human skulls; the latter of various ages, some very recent. Two species of bears had been found fossil in Ireland—viz. the cave bear (*Ursus spelæus*) and the brown bear (*Ursus arctos*), and that he believed that the subject of the present paper formed a third, viz. the *Ursus maritimus*.

Royal School of Mines.—Dr. Percy's Lectures on Chemical Geology.—Lecture II., *December* 12, 1863.—In the first lecture, the subject of silicon, one of the chief components of the solid crust of the earth, was considered. This silicon has only of late been carefully studied. It is certainly one of the most remarkable and important elements which we possess. It occurs, as will be remembered, in three distinct forms; the pulverulent state, or amorphous condition of silicon, which is extremely divided, and perfectly non-crystalline. It is in the form of a chocolate-brown powder, and it is indeed only recently that we have seen silicon in the crystallized state. We have it next in the graphitoidal state, or state resembling graphite. It occurs in the production of aluminium, or, at all events, it was first discovered in the making of aluminium by a particular process. It appears in the form of six-sided prisms, having a more or less metallic lustre and a dark bluish-black colour. Then we have what is termed the octahedral form of silicon. In many characteristics it is very similar to the graphitoidal. In colour, for example, one can hardly distinguish between the two. It crystallizes in the regular cubical system to which the regular octahedral belongs. Now, it is a curious thing that there is a remarkable analogy between silicon and carbon. Every chemist knows that there are very small chemical relations existing between the two; but with regard to the particular states in which the elements occur, we find an analogy obtaining. Thus, we have common charcoal, which is the amorphous or non-crystalline form of carbon; we have the amorphous or non-crystalline form of silicon; we have the graphitic form of carbon, exactly corresponding to the so-called graphitoidal form of silicon; lastly, we have the diamond, which is the crystalline form of carbon, and corresponds exactly to the octahedral form of silicon. In fact, silicon in this state has been called the silicon diamond.

How this silicon can be obtained belongs rather to purely chemical investigation. There is a compound, well known to chemists, called silico-fluoride of potassium or sodium. The transparent, colourless gas, consisting of fluorine and silicon, combines with potassium or sodium, forming a definite white salt—silico-fluoride of potassium or sodium. If we bring in contact with that salt some sodium or potassium, and also add a little common zinc, and heat the mixture, silicon is separated—displaced from its combination with fluorine by the sodium, and is immediately caught by the metallic zinc. The temperature should be such as to keep the zinc in a molten state. The silicon so separated dissolves in this molten zinc, and, on solidification, it separates more or less completely from the metallic mass in a definite, beautiful, distinct crystalline form, the silicon being dissolved through the mass of zinc. Common hydrochloric acid dissolves the zinc and leaves the silicon unacted upon. In this way these crystals can be obtained. Notwithstanding the powerful affinity of silicon for oxygen, and the great exercise of force which it requires to separate the oxygen from the silicon in the state in which they are combined in silica, yet, when the silicon is separated, it is astonishing how remarkably stable it is. It may be exposed to the air for an indefinite time without undergoing the least change. You may heat it, indeed, to a very high temperature, even with access of air, yet it shall not be oxidized. You may expose it to the action of various strong chemical reagents, and yet it shall undergo no change. It is extremely remarkable that a body which possesses such a strong affinity for oxygen, and requires the exercise of so much force to separate it from oxygen, should be so stable when separated as we find it to be. Exposed to a high temperature it fuses. A specimen of fused silicon was exhibited, furnished by Mr. Matthey, of Hatton Garden. This silicon is now playing a very important part in certain metallurgical operations. For instance, in the smelting of iron we find pig-iron produced in various furnaces containing a considerable portion of silicon, sometimes even as much as eight per cent., and frequently three or four per cent. The presence of it in iron modifies the properties of the latter considerably. It combines readily enough with copper. If we take a little copper or iron in a more or less divided state, say in the form of filings, and mix these filings with common sand (a compound of silicon and oxygen), and add an excess of charcoal, making a mixture of the three, and let the amount of charcoal and sand be such that, when we expose the mixture in a crucible to a high temperature sufficient to melt the copper or the iron, as the case may be, there should be sufficient of this mixture to retain the metal diffused through the mass, and then expose the mixture to a high temperature for a few hours—all the silica, under the conjoined influence of the carbon and the metal, is decomposed, the carbon laying hold of the oxygen, and escaping in the form of carbonic oxide, while the silicon is set free, combining with the metal. Common copper treated in this way—heated with sand and charcoal for a long time—undergoes a great change in its external appearance. It has no longer the red colour of copper, but has the appearance of bronze, which is a mixture of copper and tin. It is so like the bronze of which our guns are composed, that an inexperienced eye would not distinguish the one from the other when they are side by side. It is a very valuable alloy, so that you see that silicon may play a very important part even in the common arts of this country. To give another illustration of the fusion of silica. Platinum is a metal which requires a very high heat for its fusion. If we heat silicon in contact with platinum at a high temperature, no change will take place; but add a bit of charcoal, and repeat the experiment. The silica instantly becomes reduced under these conditions, and the silicon set free combines with the platinum, forming a very fusible compound.

The lecturer added a few more words concerning the proofs—the mineralogical or geological proofs—relating to the aqueous origin of crystallized silica, and they are very conclusive. Let us look at our mineralogical cabinets, and examine the specimens of quartz which we find therein. One was exhibited, a very small one, which, when examined minutely, was found to surround a mineral called hæmatite, consisting of peroxide of iron and water—a mineral which loses its water at a very low temperature. There it was, embedded in the quartz, clearly showing that the quartz never could have been exposed to a high temperature. Here is another mineral, carbonate of iron, embedded in the quartz, and the existence of this and the peroxide clearly shows that that quartz never could have been exposed to a high temperature, and supports the conclusion at which we have arrived touching its aqueous origin. Then we find incrustations which lead to the same conclusion.

With regard to amorphous silica, there is no doubt whatever about its aqueous origin. We can trace its origin in the clearest and most distinct way. In Iceland, for example, it is abundantly produced in the geysers. Here is a specimen which has been obtained from that source. Then, again, here is a specimen of granite from Iceland, on which is deposited a thin film of silica, having a pearly lustre. There is no one who will venture to say that that could have been thrown down on to the granite except by the agency of water. The specimens are very small in themselves, but, nevertheless, they speak very eloquently of the origin of silica, and tell an important tale, small as they are. Here is a very characteristic specimen showing the occurrence of crystalline quartz in two states on the very same portion of this mineral. One is the chalcedonic, or apparently non-crystalline. The lecturer used the word *apparently*, because the substance has been found to be composed of minute crystals. Close in contact with this is the other state, which is more or less non-crystalline; and then occurs a sort of granite deposit, which, seen under a magnifying glass of high power, is seen to consist of distinctly crystalline quartz. Amorphous silica exists in the shells of living infusoria; and it is found also in a siliceous concretion met with in the joints of the bamboo, known as tabasheer; it occurs also in petrified wood.

The lecturer next took up the subject of flint—a subject which has recently given rise to so much discussion. All were acquainted with the discovery of those wonderful nodules of flint in chalk, the formation of which is involved in doubt, notwithstanding that they are associated with the presence of sponge, and so on. There are, however, chemical difficulties which arise, and which will require much time to solve completely. When we take one of these dark flints, and expose it gradually to a temperature which we bring at last to a bright redness, it becomes very tender and fragile, and it would become especially fragile and perfectly opaque if heat were rapidly applied. It is in this way that the flints prepared for the use of potters are rendered fragile in the first instance, preparatory to grinding. Now when we examine specimens of flints we are frequently struck with an opaque white outer film, where the flint has lain in contact with chalk. This film or rind, if I may so call it, extends to a considerable depth. Well, what is it? Is there any chemical difference between this white rind and the inner dark portion of unchanged flint? This is a question which we have examined with some care, and by the aid of the most careful chemical analysis we are unable to detect any sensible difference between the two. The only conclusion therefore is, that the difference of appearance is owing to some molecular change; but how it is excited the lecturer was not prepared to say—whether by the slow operation of time, or whether, perhaps, by simple vibrations. It has often struck me, with regard to the flints which I have seen on the seashore, which have presented a white appearance, that possibly that appearance may have been caused by some operation of that kind; but upon that point he spoke with the greatest possible reserve. It is of very great importance to know exactly the effect of weathering upon the surface of flints, especially with regard to the great question now agitating the public mind concerning primeval man. Here is one of those wonderful things hewn out of flint by our rude forefathers, for the loan of which he was indebted to his friend Dr. Falconer. It presents a fracture at one end, which is very different from the contiguous portion; but at another portion there was observed to be the characteristic dark appearance of these ordinary flints. He had been examining this specimen, and upon the whole he thought it must have been long exposed, subject to some condition by which the surface has been changed. Then comes the question, whether it is possible to imitate these signs of age upon counterfeits of ancient flint implements. He thought a few experiments would very soon settle the point whether it is possible to give a surface very much resembling that which we find in these old weapons, by some chemical means.

With regard to the permeability of these flints by liquids, it is astonishing how pervious they are. If we immerse flint in sulphate of indigo and water, and keep it there some weeks, the indigo will penetrate to some depth.

It has been alleged, and it is a point of some importance, that silica may be volatilized, especially by the agency of steam. Every chemist knows that boracic acid, which is a fixed body, may, by the agency of steam, be vaporized to a considerable extent. A case of the volatilization of flint was recorded some years ago by Mr. Julius Jeffreys. It occurred in a potter's kiln in India. His statements have been repeated by many journalists, both British and foreign. It is important that we should examine the ground upon which he arrived at his conclusion. He allowed a large quantity of steam to pass through a potter's kiln, of which the temperature more than sufficed to melt pig-iron, and he afterwards observed round the opening of the kiln from which the steam escaped, several pounds of silica deposited in the form of snow. In commenting upon this statement, Berzelius, who accepted it, adduces as a parallel case the well-known volatility of boracic acid under the same conditions, and the fact observed by Gaudin concerning the volatilization of silica when melted before the oxy-hydrogen blowpipe. Now, the lecturer had examined all the original statements concerning this allegation, and he must say that the conclusion to which he had arrived is, that it is altogether unsatisfactory. There is no proof whatever, or, at all events, there is none advanced, that the deposit was silica at all. No analysis was made, and no man is justified, without the evidence furnished by analysis, in pronouncing definitely upon a point of this kind. Secondly, admitting that the substance called silica was really silica, there is no evidence to show that it was volatilized in the way described. We perfectly well know that in metallurgical operations a very large amount of finely-divided matter may be carried to a very long distance mechanically by gases or vapours floating over it. Volatilization is something different from the mechanical removal of the particles of a substance.

The subject next taken up was one of great interest—aluminium. This aluminium plays a most important part in this world, so far as the formation of the crust of the earth is concerned. It is one of the chief constituents of, and forms an essential part of, all clay. It exists almost everywhere in a greater or less proportion. It is undoubtedly one of the most beautiful elements of which this world is formed, or the external part of it rather.

Aluminium has of late excited a great deal of attention. Formerly it was known only very imperfectly, a few grains only having been obtained. now it is produced by the hundredweight. The metal has a bluish-grey colour,—intermediate between tin and zinc in point of colour, being not so white as tin, and less blue than zinc. It is by far the lightest of all metals now used in the arts, its specific gravity being in round numbers 2·5; that is to say, whatever measure of water weighs 1, the same measure of aluminium will weigh 2·5.

Aluminium has a most powerful affinity for oxygen. When combined with that element, it constitutes the well-known base alumina. Like silicon, although it has this strong affinity for oxygen, yet when we succeed in detaching it from oxygen, and obtaining it in a compact, solid form, it is remarkably stable, and might be exposed indefinitely to the air without undergoing oxidation to any extent. When melted, it oxidizes on the surface and forms alumina. This acts as a coating, and protects the subjacent molten metal from further oxidation.

Aluminium is obtained from a salt termed chloride of aluminium. If we take alumina, which is aluminium and oxygen, and heat it with charcoal even to a high temperature, we cannot, so far as we know, succeed in eliminating the oxygen and detaching the aluminium; but if we make the salt called chloride of aluminium, then we can, by means of a metal having a powerful affinity for the chlorine, succeed in separating the aluminium completely. The first process was to take aluminium and mix that with charcoal, and then to make the mixture into small pellets. Now, charcoal at a high temperature has an affinity for oxygen; and if we expose that mixture of alumina and charcoal at a certain degree of heat to the action of chlorine, we then get chloride of aluminium. We have then two affinities coming into play—the affinity of the oxygen for the carbon, and of the chlorine for the aluminium, and by means of this twofold force we form this body, having a yellow colour, called chloride of aluminium. We then place that chloride of aluminium in a glass vessel, which was the way it was formerly prepared, and expel the air by means of a hydrogen gas, and then introduce the vapour of sodium by a new application of heat to the exterior, in contact with the vapour of the chloride of aluminium. The result is the formation of chloride of sodium or common salt, and the separation of the metal. There is one other source of aluminium from a curious mineral called cryolite—one of the highest possible interest. Here is a specimen from Greenland. This consists of the elements fluorine, aluminium, and sodium. Well, to any mineralogist and chemist who reflected upon its composition, it would naturally occur that, if we could bring that substance into contact with sodium at a high temperature, we should produce aluminium. The thought occurred here some time ago, and the very first specimen produced was produced in this place. That specimen was shown some time ago at the Royal Institution.

Alumina is a compound of oxygen and aluminium. It contains, in round numbers, 53·3 per cent. of aluminium, and, consequently, 46·7 per cent. of oxygen, and its chemical symbol is $Al_2 O_3$. When dry, it forms a white, tasteless powder, insipid and insoluble. This powder is fusible only at the very highest temperatures we can command; in fact, it is singularly infusible. In that state it is entirely amorphous. It has the property of combining with water in several proportions, producing a plastic clay-like mass. Compounds of this kind occur in nature. One hydrate—that is to say, one water-compound of alumina—occurs beautifully crystallized. That is the well-known diaspore. Then we have a non-crystalline variety in the form of Gibbsite. This diaspore is a compound of one equivalent of alumina and one of water. Gibbsite, of which you have a specimen before you, is a white, amorphous, or non-crystalline body, and is a compound of one equivalent of alumina and three of water. Alumina crystallizes magnificently, producing that glorious mineral (excuse the emphatic expression) called corundum, which, when blue, is known to you as sapphire, when red as ruby, when yellow as oriental topaz, and when green as emerald. We have here a specimen of corundum which is coloured, forming these various minerals respectively. We shall speak of the mode of formation presently.

Alumina acts in the twofold capacity of base and acid—that is to say, it unites with acids forming definite salts, and it also acts as an acid forming definite salts. It appears as common alum in the first of these states. If we take the well-known base magnesia, or lime, or oxide of zinc, and mix them with alumina in certain proportions, we get the minerals called spinels, the alumina acting as silica would under corresponding circumstances.

There are various salts of alumina in nature. One of these is wavellite, or phosphate of alumina. Alumina may be precipitated easily by taking a soluble salt of alumina, dissolving it in water, and adding a little ammonia to it; it then forms a dense white precipitate. In that state it is combined with water. It is perfectly soluble in caustic potash, which combines with it, and forms a clear solution.

As far as we know at present, it does not appear that the process of dialysis can have played a very important part with regard to the formation of alumina in nature, or rather in the separation of alumina. Professor Graham has spoken of the dialysis of certain salts of alumina. For instance, one of these is basic acetate of alumina, which may be decomposed by dialysis. The chloride of aluminium is another. There is, however, a salt which he has not examined at present; that is the sulphate, and that is the most likely of all to occur in nature. Therefore, for the present, we have no reason to suppose, from the experiments reported, that this process has any applicability to the formation of alumina in nature.

Now, let us look at crystalline alumina. This is a subject which has a bearing upon geological phenomena. A minute crystal found in a rock shall be a clear exponent of the formation of that rock. However small it may be, it shall tell a most eloquent and indisputable story with reference to its origin. He thought that what he said was not overstated with regard to the formation of some of the mineral constituents, though occurring in small quantity in some of our so-called "igneous" rocks.

The late distinguished, most excellent Professor Ebelmen made numerous experiments upon the subject of artificially-crystallized alumina. He exhibited specimens received from him years ago. They are exceedingly small, but remarkably characteristic. Here are some small scales of alumina crystallized by the operation of fire. The process consists of heating alumina, mixed with about three or four times its weight of borax, in a small platinum crucible, under certain precautions, in a porcelain furnace—a porcelain furnace where we obtain hard porcelain, and not the so-called porcelain which we make in this country, and which is made at a low temperature. It must be the true China porcelain furnace, such as was in operation at Sèvres, where he experimented. He exposed the borax and alumina at a high temperature in this furnace. The borax dissolved the alumina, and after a time off went the boracic acid and the sodium. The crystallized alumina remained at last in brilliant colourless scales. This is exceedingly similar to what is obtained at ordinary temperatures with liquid solvents. It is only just to the memory of poor old Berthier, who died not long ago, to state that the lecturer found, in looking over his papers, that he really was the first man to adopt this mode of forming mineral substances, and obtaining them in a crystallized state. He did not use borax, but he used an equivalent, namely, common salt. He formed crystallized silicate of lime and magnesia by exposing them with salt on precisely the same principle as when borax is used. We are indebted to Deville for that which is now the commonest process, and it is a very beautiful one. The operation is performed in a common crucible. He lines that with charcoal, which is a common process,—what we call brasquing,—thus making an inner lining of charcoal all the way; then above he puts a little capsule or cupel, made of charcoal,—a little cup-shaped piece of charcoal; he then covers the whole with a charcoal top, and afterwards places on the cover, and lutes it down.

In the lower part of the crucible he puts fluoride of aluminium; in the upper part he puts fused boracic acid. He exposes the whole to a high temperature, and the two bodies vaporize. The two vapours come into contact, and they actually decompose each other; and the result is, that the fluorine goes away from the aluminium, and combines with the boron contained in the boracic acid, and then escapes as fluoride of boron, and the oxygen of the boracic acid unites with the aluminium, and forms the beautifully-crystallized substance corundum. Here, then, we can make sapphire in this way most beautifully. At present our artificers have not directed much attention to it, but there is no reason why, if we carried out this branch of investigation, many of our gems might not be produced in this way.

These crystals are generally rhombohedral, terminated by the faces of the regular hexagonal prism, and according to Deville, they possess all the optical and crystallographical properties of natural corundum. Well, then, by just varying this process, we get the true oriental ruby—not the less valuable kind called spinel, but the true characteristic ruby—simply by adding a little fluoride of chromium. The process must be conducted in an alumina crucible,—the boracic acid must be placed in a platinum cupel. Sapphire is produced in exactly the same manner, and the same colouring agent, namely, fluoride of chromium, is made use of. The reason of this is very obscure. Side by side we may get some of the crystals coloured blue, and some coloured red. The difference is possibly due to a difference in the oxidation of the chromium, but that is a point not as yet clearly revealed by analysis. It is a very peculiar thing. The same thing occurs in certain experiments with glass. We know nothing by analysis of the colouring-matter of the sapphire. Whatever it is, it has escaped detection by analysis. Here, by means of the same colouring agents, and under the same conditions, or apparently under the same conditions, we produce sapphire and ruby. Sometimes we find this corundum passing into sapphire, being blue in one part; and jewellers, in setting such things, try with great skill to make it appear that the colourless corundum is coloured, and they set it in such a way that the whole shall appear blue. By increasing the proportions of the chromium salt, Deville obtains a fine, rich, emerald green—an oriental emerald-green corundum. This is simply by increasing the quantity of the chromium. Now, it is very peculiar that we can thus succeed in producing artificially one of the finest minerals, except the diamond. The diamond will come ultimately, no doubt.

Now, there is another process contrived by Debray, which appears to answer perfectly well. This consists of calcining phosphate of alumina with three or four times its weight of sulphate of soda or potash. He gets, then, tribasic alkaline phosphate and crystallized alumina.

Alumina may be melted by oxygen and the flame of a spirit-lamp into glass-like beads, which are stated to be always more or less crystalline on cooling. Gaudin, especially, is the man who, many years ago, experimented upon this subject. The smallest globules show crystalline faces, and they are said to be so hard that their edges will cut glass. Sapphire, whether natural or artificial, is the hardest mineral known except the diamond. Alumina, when melted in the way spoken of, is said to be very liquid. By the addition of a very little chromate of potash during fusion, Gaudin obtained a more or less deeply-coloured red product, similar in colour to the natural ruby. It is reported to be more or less crystalline, and to possess extreme hardness.

Now, how does corundum occur in nature? It is interesting to ascertain this point. It occurs frequently in limestone, forming the so-called stratified granite in Newton, in New Jersey, and in New York. It occurs in layers with marble, in the gneiss of the Isle of Naxos, and also similarly in the Isle of Lemnos, and at Magnesia, in Asia Minor. It is there associated with magnetic iron or crystallized magnetite. It occurs along with diaspore in the dolomite of St. Gothard. It occurs near Ephesus, and also in the Isle of Naxos, in the same way. Here are five specimens of corundum in its opaque, common form. In its finely-divided state it is commonly known as emery, which is nothing more than the common form of the true sapphire. Some of the analyses of this substance give water as an essential constituent, but the sapphire and the ruby are nothing more than crystallized alumina without water. But there are analyses of some two or three specimens of corundum in which we find water given as a constituent. An analysis of corundum from Asia Minor gives 3·7 per cent. of water, and an analysis of corundum from India gives 3·1 per cent. of water. In these cases, probably, they contained diaspore associated with them. There is a difficulty in many of these analyses, and we cannot extract rational formulæ of the results obtained by approximate analysis, because these crystals have the power of enclosing within their mass a very large amount of matter which in no way enters into the chemical composition of the mineral itself. It is there as so much foreign matter entangled in the crystal, and yet the crystal shall have a definite form, and so forth. There is a portion of matter which we must not take cognizance of, but we have no means of separating it mechanically from the mass. It all comes into our results, as we have no way of separating this dirt, as metallurgists call it.

Now for some examples of the so-called aluminates. There is a form of ruby which is an aluminate of magnesia. It is coloured a fine rich colour, apparently with chromate of potash; but of course it is not equal to the oriental ruby. It consists of one equivalent of magnesia and one of alumina. Its formula is, $MgOAl_2O_3$, so that you see that the alumina contains three times as much oxygen as the magnesia. It may be obtained beautifully crystallized, and was so obtained by Ebelmen. It is made simply by heating magnesia and alumina with fused boracic acid, with the addition of a little chromate of potash. The experiment was made in exactly the same way as that with reference to the crystallized alumina prepared in the porcelain furnace at Sèvres, near Paris, already spoken of. Ebelmen obtained in this way distinct crystals of aluminate of magnesia, having a fine ruby-red colour. They are exceedingly small, but they are, nevertheless, instructive, small though they be. Then, by adding a little cobalt, he obtained crystals of the same form, having the characteristic and beautiful blue colour of the natural mineral.

NOTES AND QUERIES.

Typical Mammalia in British Museum.—Dear Sir,—Allow me to point out to you an omission in your list of figured specimens of fossil mammalia in the British Museum ('Geologist,' March, 1864). I have lately described and figured, under the name of *Hyæna antiqua* (Annals and Mag. of Nat. History, January), a molar tooth from the Red Crag of Suffolk, which is now in the national collection. As this announcement may stimulate others to search in the same direction, I trust you will insert it in your journal.—Truly yours, E. Ray Lankester.

8, *Savile Row, W.*

FARRINGDON GRAVELS.—Sir,—In his paper on the Farringdon Sponge-gravel, in the January number of the 'Geologist,' Mr. Meyer says that "it is no new idea to compare the Farringdon deposits to the sands and gravel of Devizes" (Lower Greensand). I have always thought that nearly all geologists classed the Farringdon beds with that formation. Mr. Hull has mapped and described them as such in sheet 13 of the Geological Survey Map, and at page 13 of the Memoir, illustrating that sheet with regard to the order of the beds, Mr. Hull says, "The beds at Farringdon are divisible into two groups; the lower being the fossiliferous gravel and conglomerate, the upper, clays and sands, with iron-bands," which agrees with Mr. Meyer's conclusion, that the Sponge-gravel is the oldest of these deposits. I am yours, etc., W. W.

ERRATA—MR. WHITTAKER'S LECTURE.—Page 58, line 8, after "until" insert "in;" page 58, line 9 from bottom, after "altogether" insert "of;" page 58, line 5, for "supposed" read "supposes;" page 59, line 16, after "Cray" insert "the;" page 59, line 34, before "*London*" insert "*the;*" page 60, line 3, for "abundance Cyrena, Cerithium, and Melania" read "abundance (Cyrena, Cerithium, and Melania);" page 61, line 13, erase the bracket after "common," and insert it after "rays" in the following line.

CAUSE OF THE GEYSERS.—In Mr. Reed's paper "On a New Theory of the Generation of Steam," before the Liverpool Philosophical Society (1862–3), he gives the following summary of the principles laid down by Mr. Williams, the originator of the theory:—

"1st. Water, or its atoms, can neither be *heated* nor *expanded* and still retain the character of liquidity.

"2nd. The prevailing theories as regards *ebullition* are altogether erroneous.

"3rd. The so-called *boiling-point*, as regards temperature, is merely that point at which the water is charged with vapour *to saturation*, under the true Daltonian theory, the water acting the part of a mere *vacuum or medium.*

"4th. We have strong grounds for believing that there is no difference between the *cause* which produces divergence and mutual repulsion among the atoms of a liquid on becoming vapour, and that which produces a similar divergence and repulsion in the pith-balls or gold leaves of the electroscope.

"5th. If there be such a thing as *Thermo-Electricity*, we are warranted in concluding that it acts in the same way, and on a similar principle, on atoms of a liquid as on those of other bodies.

"6th. We have rational grounds for believing that *explosions* in steam-boilers are frequently the result of the accumulated steam (present in the body of the water) being suddenly released by the removal of the pressure from the *denser* medium of the water into the *lighter* one of the air.

"7th. Watt's theory of steam being *condensed*, and reconverted into the liquid state, by the direct action of cold water, is altogether erroneous.

"8th. Vapour or steam cannot give out its heat to water, and is but mixed, *mechanically*, with it, on the true Daltonian theory."

He next applies the theory to the explanation of the Iceland Geysers:—

"They may be," he says, "briefly said to consist of more or less violent discharges of steam and what is called boiling water from subterranean sources, each through an upright tube, which opens out above into a capacious basin. In accounting for these hot springs, the existence of subterranean heat is, of course, always assumed; but opinion has been greatly divided as to the *modus operandi* of its application. One class of writers, of whom Sir George Mackenzie may be taken as the representative, considers that sudden evolutions of heat occur; that these have the effect of generating volumes of steam, which accumulate in cavities with sufficient pressure to sustain the column of water in the Geyser tube; and that further sudden accessions of heat and steam produce vertical oscillations in this column of water, during which the steam finds opportunity to escape, and carries up with it a great part of the water. Another class of writers have adopted a theory put forward by Bunsen, in which the Geyser tube alone, without a subterranean cavern, is supposed to contain water, heat being applied to the tube itself, and the relief of pressure which results from the elevation of the upper portion of the water playing an important part in the operation. In this case, however, as in the former, the notion of steam being *suddenly* generated is preserved, heated rocks being supposed to furnish the necessary supply of local heat.

"Now, Mr. Williams's theory most amply and beautifully accounts for all the phenomena of these Geysers, without assuming the existence either of intense local heat or of sudden evolutions of heat. Simply assuming the existence of a subterranean heat of some kind—and all now admit the existence of that—also the presence of water in and below the tube, and, in his view, the generation and accumulation of steam must take place. As the quantity of this steam goes on increasing, the moment will arrive when the saturation of the water will have taken place, and after that a more or less violent discharge of steam must follow. It seems reasonable to suppose that the Geyser tube is not an isolated reservoir, and that it opens into wells or springs below of greater or less extent; and in this way the enormous amount of the discharges that issue from these Geysers may be accounted for, whereas the tube alone seems of wholly insufficient capacity to supply them.

"I would now ask you to observe the apparatus which we have here, and which Mr. Williams himself constructed. It consists simply of a tube opening into a vessel of water below, and a basin above, the tube and lower vessel being filled with water which rises up and partly fills the basin. Heat is now applied below; steam is, as we think, accumulating in the water; now you hear explosive sounds and observe commotion in the fluid; and now a violent and copious discharge of steam and water-bursts, Geyser-like, from the basin. The action now subsides; the water returns from the basin down the tube to the reservoir below; and presently all these phenomena will repeat themselves, just as they do in nature. The Geyser, then, like the miniature working model before us, consists of a large reservoir below, a single tube or orifice of exit, and a basin above, which receives a large portion of the ejected water, to be returned to the reservoir below. This reservoir being necessarily full of water, the steam generated must remain and accumulate in it until the point of saturation has been reached, which will depend on the height of the column of water in the vertical tube of exit, the temperature in the reservoir corresponding with that elevation. In the miniature, that temperature is found to be 215° when the discharge takes place. In the Geyser, this must be considerably higher, the tube of exit being there 47 feet. We thus see that the Geyser and its miniature correspond in action and result."

SHELL-MOUNDS.—Dr. Collingwood, in the Proceedings of the Liverpool Philosophical Society (1863), says, "My friend Mr. I. Byerley, of Seacombe, has met with remains on the shores of the Mersey, which appear to resemble the deposits known as *kitchen middens.* He informs me 'that strata of shells exist at Wallasey, and in the sand-hills along the shore, between Leasowe and Hoylake, which seem to resemble, on a small scale, the collections noticed by Mr. Lubbock, under the name of 'shell mounds' in Scotland, and of 'Kjökkenmöddings' in Denmark. On going down the hill, just before entering Wallasey village, there is a bank, which may be twenty feet or more high, on the right-hand side; two-thirds of its height is composed of sandstone, above which is a covering of earth from four to six feet in thickness; between the latter and the sandstone, a stratum of mussel-shells, about eight inches thick, may be seen. The shells are partly whole and partly broken; all, of course, are free from epidermis, but the striated colouring is as distinct as in recent specimens of the species. Having, however, lost much of their animal element, they are more friable; and on being placed in water for the purpose of cleansing them, the outer layer of shell-structure readily separates from the nacreous interior. This stratum appears to have no other species of sea-shell intermingled; the terminal whorl and apex of a univalve, however, was just perceptible, which, on careful removal from the matrix, proved to be *Helix aspersa.* This bed is about a mile from the present sea-shore.'

"The same gentleman has also observed either one or two strata of shells in the sand-hills, on the shore between Leasowe and Hoylake. Not having visited the spot for some years, however, he can only report from memory that they are composed exclusively of cockle-shells. It is worthy of remark that these beds are situated very close to the place where the Anglo-Saxon antiquities were found at the Great Meols.

"May we not infer that these shell-strata are composed of the castaway refuse of mollusks, which had been consumed as food by our prehistoric ancestors?"*

MAMMALIAN REMAINS.—Dr. Collingwood, in the course of his paper "On the Ancient Fauna of Lancashire and Cheshire,"† records the following:—*Hippopotamus:* "of which a complete skull is figured in Leigh's 'Natural History of Lancashire' (1705), dug up under a moss" (tab. vi. fig. 4‡). *Megaceros:* "antlers, in marl or gravel, beneath peat," in Lancashire. *Bos primigenius:* from "submarine forest." *Cetacean:* rib of, from excavations at Wallasey Pool; and humerus of a *whale*, from peat of submarine forest, opposite Leasowe Castle. *Cervus elaphus:* Pennant says that horns, "evidently of the stag kind, but much stronger, thicker, heavier, and furnished with fewer antlers than those of the present race, have been found on the sea-coast of Lancashire" (Phil. Tr., No. 422); and a single horn was dug out of the sands near Chester (Brit. Zool., vi. p. 62); four horns from Wallasey Pool. Hopkins transmitted the sketch of an antler to the Royal Society (figured in vol. xxxvii. No. 422, Phil. Trans.); this was drawn out of Ravensbarrow Hole, adjoining Holker Old Park, Lancashire, by the nets of the fishermen, in 1727; similar horns from the submarine forest of Leasowe; other horns described and figured by Leigh in Nat. Hist. Lancas., pl. 5, as "head of a *stag of Canada*" (*i. e. Cervus Canadensis*, the Wapiti), an error; the former being those of the red-deer, found "8 yards within the marle" in Lancashire; and one as huge again, "4 yards under the moss in the Meales;" also others in Camden (Brit., iii. p. 142). *Elk* or *moose-deer* (?), 1845, in submarine forest of Leasowe, according to Dr. Watson, on the identification of Dr. Scouler; also Mr. Geo. Thompson, "head and antlers" in 1857. The specimens are said to be deposited in King's College Museum; but Dr. Pollok, the Curator, says they do not exist in that collection. *Horse:* "almost entire skeleton of a small size, equalling the Shetland pony in height, and remarkable for the large proportion of the head;" found by Mr. E. T. Higgins, of Eastington, Gloucestershire, in the ancient forest-bed of Leasowe; also *Sus*, roebuck (?), and "a dog [or wolf,—S.J.M.] about the size of a greyhound." *Boar:* "tusks, in digging a cellar at Lancaster, in company with Roman remains." *Man:* human skull, in sandy gravel, 10 feet below the original bed of

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* Several remains of Mollusca characterize the glacial deposits on the banks of the Mersey, such as *Tellina solidula, Nucula oblonga,* Cardium, Nassa, and particularly *Turritella communis,* which passes upward from the sandy gravel of the lower drift deposit into the boulder-clay above. From a well sunk at Poolton, in Wirral, fragments of Mactra, Venus, Astarte (?), and other shells were also obtained.

† Proceedings of the Liverpool Philosophical Society, 1863, part xvii.

‡ Also figured by Buckland in Rel. Dil. part xxii. fig. 5, and mentioned by Owen in Br. Fos. Mam. p. 401.

Wallasey Pool, and "in close connection with the ancient fossil oxen above referred to."

MR. HASWELL ON THE DENUDATION OF ARTHUR'S SEAT.—My attention has been drawn to an article which appeared last Saturday in a weekly contemporary. That article was entitled "Geological Plagiarism," and commented on the appropriation of passages and ideas from Mr. Geikie's contribution to the geology of Edinburgh in the 'Memoirs of the Geological Survey' for 1861 in the article printed in the number of this magazine for the past month "On the Denudation of Arthur's Seat." No one will, I am sure, believe me capable of knowingly permitting such plagiarism to appear in these pages; and even the writer of the criticism referred to in no way attempts to put such an imputation upon me. As far as I am personally concerned, I was in total ignorance of the existence of Mr. Geikie's paper. The publications of the Geological Survey appear in a very erratic manner, and as I am in no way personally interested in Scottish geology, and do not, as I think as editor of this magazine I ought to do, receive gratuitous copies of the works issued by our national survey for review, I naturally only purchase such portions as I have individual need of. Such is the brief explanation of the cause of Mr. Geikie's paper not being known to me.

Having been visiting the scene of the late disaster at Sheffield, it was only since my return that I knew of the article in the contemporary referred to. I at once forwarded a copy of the article to Mr. Haswell, who is not personally known to me, with the request that he would take the matter up. Time sufficient for his reply not having elapsed, it will be obvious that further remarks of mine at present would be unjust to a contributor, and could be neither sufficient for my own wishes, nor for that due apology which, if the case be truly stated, is undoubtedly due to Mr. Geikie. S. J. MACKIE.

26th March, 1864.

WORKS OF ART IN CAVERNS IN CENTRAL FRANCE.—Dr. Falconer has communicated the following letter to the 'Times:'—

"Sir,—Since the exploration of the Brixham Cave in 1858 an immense impulse has been given all over Europe to the search for and study of the material proofs of the antiquity of the human race. The public mind is now craving for information on a subject which a few years back was condemned by the general verdict of men of science, and hardly mentioned except in a whisper. Fresh evidence is being brought to light, day after day, of the most interesting and important character, although not tending to carry man back, in every particular instance, to a period of very high geological antiquity. The south of Europe is the quarter whence the current is now flowing, and the ossiferous caves the springs whence it issues. Professor Busk, in a recent communication ('Reader,' 30th of January) has given a very clear and excellent account of discoveries made within the last year in a bone-cave in Gibraltar. The materials, not all yet arrived in England, are now under investigation, and give promise of results of high import. But the most interesting additions have been yielded, very lately, by caves in Central France, where what may be called works of art, of primitive execution, have turned up in considerable abundance, which prove that savage man, of the unground and unpolished stone period, was able, in advance of the use of metals, to sculpture on deer's horns, and to grave on stone, figures of quadrupeds his contemporaries that are now extinct in that region. My friend M. Lartet, on behalf of himself and Mr.

Henry Christy, his *collaborateur* in the work, communicated to the Academy of Sciences on the 29th ultimo an account of these relics, which, when exhibited, produced an unusual sensation among the learned Academicians. I purpose now giving a brief sketch of this new and certainly very ancient walk of art, drawn mainly from M. Lartet's paper, which will speedily appear in the 'Comptes Rendues' and from figures of the objects.

"The proofs of the remote antiquity of man are derived from two sources —1, the ancient, or 'quaternary,' river gravel-deposits; 2, the ossiferous caves. The former, handled with the severe caution of Mr. Prestwich, carries man furthest back in time, and with the greatest certainty; but it is of the most meagre and restricted character, consisting merely of flint weapons or implements, hardly ranging beyond a few patterns. Not a single instance has yet occurred of a fragment even of an unquestionably authentic human bone having turned up in these deposits. On the other hand, the evidence yielded by the caves, although less certain as an index of remote time, is infinitely more varied and instructive. It tells us, in certain cases, the division of the human race to which man, the early tenant of the caves, probably belonged; what was his stature and what his physical powers; what the animals which were his contemporaries; what the mollusks, fish, flesh, and fowl upon which he fed; that he cooked his meat by fire; that he extracted the marrow from the bones, and how he did it; how and with what weapons he killed his game; how he flayed and dressed the hides; that he scraped the meat off the bones; that he carefully cut the sinews of his slaughtered deer for harpoon lines, or for the fibre of sewing-thread for his fine-pointed pierced needles; where and in what direction he cut the sinews; what the implements and weapons—in stone, bone, and deer's horn—which he used; what his ornaments, and how he disposed of his dead. It is now beginning to enlighten us on what he was capable of achieving in the way of art, and that in music he had got the initial length of a bone whistle limited to a single note. The cave evidence has been disparaged by cursory observers and light reasoners, upon the grounds that the caves have been occupied at different times, and their contents often disturbed by the latest tenants, thus forming what are called *remanié* deposits. But the shortcomings lay with the objectors themselves. When the profound palæontological knowledge, rare sagacity, and philosophic caution of M. Lartet are applied to what were sources of doubt and embarrassment to them, the supposed difficulties are converted into aids in unravelling the tangled clue, and into indices of ulterior truths. In short, beside the bare fact that primeval man existed during the early 'fluviatile drift period in Europe,' all that we know of him—exclusive of the later 'kitchen-middens' and 'pile-habitations'—is derived solely and entirely from the ossiferous caves.

"The caverns which, on this occasion, were the objects of exploration by M. Lartet and Mr. Henry Christy, occur in the department of the Dordogne (the ancient province of Périgord), and in the arrondissement of Sarlat, in the south-western part of Central France. The most productive localities were the cave of 'Les Eyzies,' in the commune of Tayac, the cave of 'Le Moustier,' and the shelter-recesses under the projecting cliffs of 'Laugerie-Haute,' 'Laugerie-Basse,' and 'La Madeleine,' in the valley of the Vezère; the rock-formation consisting of indurated chalk. The floor of 'Les Eyzies' cavern is overlaid by a continuous sheet of breccia, composed of a base of cinders and ashes, mingled with charcoal; fragments of bones either in the natural state, or split, scorched, or burnt; outside pebbles; flint cores with numerous fragments of flint flakes or knives, invariably of wrought forms, and associated with other implements or weapons fabricated out of reindeer's horns; the whole consolidated in a confused mass, which had never been disturbed since the period of deposition. This was established by the state of the materials and by the fact that in several cases long bones were found with their heads in articular continuity, and vertebræ of reindeer in sequence.

"The principal objects of art were as follows:—In 'Les Eyzies' among numerous fragments of a hard slate, foreign to the district, two plates were found, each bearing an engraved representation of a quadruped. One of them, mutilated by an ancient fracture, presents the fore-quarter of a herbivorous (?) animal, the head of which was apparently invested with horns, so far as the faint lines of the engraving at this part admit of judging. The other bears the figure of a head, with the nostrils sharply defined, and the mouth half opened; but the profile lines of the frontal region are interrupted in consequence of erasure by subsequent friction. On one side and a little in front is engraved the figure of the palm of a large horn, inferred by MM. Lartet and Milne-Edwards, with reserve, to be that of a moose deer. These specimens are regarded by M. Lartet as being the earliest known examples of engraving on stone, by primeval man, of the reindeer period in Europe.

"The most striking part of the collection, consisting of sculptured objects, was discovered in the shelter recesses, under the cliffs of La Madeleine, Laugerie-Haute, and Laugerie-Basse, amidst accumulations of bone-refuse and other *rejectamenta*, mingled with an immense quantity of flint flakes and the cores from which they were struck off. These spots were evidently the kitchens and manufactories of the ancient savage. The bones indicated the animals on which he fed: being the horse, ox, ibex, chamois, reindeer, birds, fish, etc. The common stag was rare, as were also the boar and the hare. Some detached molar teeth were discovered of the extinct Irish elk, and also detached plates of the molar teeth of the mammoth.

"Laugerie-Haute would seem to have been especially the locality were flint implements were made, and Laugerie-Basse that where reindeer horns were converted into spear-heads, harpoons, daggers, arrow-heads, needles, and other implements. Here an enormous accumulation of reindeer horns was discovered, the whole of which nearly bore the marks of a stone-saw, by which pieces were detached suitable for conversion. Here also were found the principal sculptured objects, some of which, considering the period and the nature of the tools, are marvels both of artistic design and of execution.

"The most remarkable is a long dagger or short thrust-sword, formed out of a single horn. The handle represents the body of a reindeer, the parts in fair proportion, and treated with singular skill and art-feeling, in subservience to the use for which it was intended. The fore legs are folded easily under the body; the hind legs drawn out insensibly into the blade; the salient horns and ears are cleverly applied to the chest by giving an upward bend to the head; and a convenient hollow for the grip of the hand is produced by a continuous curve extending from the rump to the muzzle. M. Lartet remarks that the hand for which it was designed must have been much smaller than that of the existing European races. The weapon was evidently left by the artist-savage unfinished; but, as a design imbued with taste, it will bear a very favourable comparison with Oriental dagger-handles cut in ivory.

"Another specimen is described as a handle terminating at one end in a spear point, and bearing in partial relief the heads of a horse and of a deer, probably reindeer. Others are ornamented with longitudinal and parallel wavy lines, etc. A distinct class consists of palmated portions of reindeer horns, bearing representations of animal forms,—some executed in graved lines, others in bas-relief or in high relief. One of these palmations exhibits a figure of a large herbivorous animal which has been conjecturally referred to the Aurochs. Another is supposed to represent an ox, probably *Bos primigenius* (?). The collection, judging by the drawings which I have seen, is very rich in spear-heads, barbed harpoons, arrow-heads, and finely pointed slender needles, drilled with an eye-hole. The harpoons bear a close resemblance to the Esquimaux patterns. On one object the figure of a scaly fish is distinctly represented. The ornaments consist of canines of wolf, incisors of ox and other animals, with ear-bones of horse or ox, all drilled for suspension. One curious object is the first digital phalanx of a ruminant, drilled to a certain depth by a smooth cylindrical bore, on its lower surface near the expanded upper articulation. This is supposed to have been a whistle or call, and a shrill sound is yielded on applying it to the lower lip and blowing into it. Three of these whistle phalanges are of reindeer, one of chamois. One relic of surpassing interest consists of the lumbar vertebra of a reindeer, pierced through and through by a flint weapon, which still remains embedded in the bone, fixed by calcareous incrustation. This is an object of great significance and extreme rarity. Human bones, although found, were very scarce; but M. Lartet has refrained from alluding to them, with a reserve the reason of which is indicated by M. Milne-Edwards. In forming an estimate of the value of the relics of art, the reader will bear in mind that they are the productions of the unpolished and unground 'Stone period,' the tools employed having been thin chips and delicate flakes of flint. Such, at least, is the fair inference drawn with our present lights from the negative evidence, not a trace of metal in any shape having been met with in the Dordogne Caves. But if primeval man really had made such progress in the conceptions of art without having yet attained the knowledge of metals, it will be as curious an anthropological phenomenon as are the art objects themselves, which express that degree of luxury which ease, leisure, and comfort beget. Reindeer's horn is notoriously the most worthless and incompact of cervine antlers; it is readily whittled by a knife, which is not the case with stag's horns.

"The labours of M. Lartet and Mr. Henry Christy on the Dordogne Caves commenced in August, 1863. They have been continued ever since, and are still in progress. Valuable and instructive as is the Dordogne collection, it is surpassed in certain respects by another, from the 'Bruniquel Cave,' in the south of France, more recently formed by other observers. The Bruniquel series, it would appear, does not embrace the same range of art, but it is richer in the department of weapons and implements, such as harpoons, spear-heads, etc., which are larger, more numerous, better finished, and in better preservation. These precious materials were offered in succession to the French Government and to the British Museum. 'Perfide Albion' has got them: they are now in the national collection. The result does infinite credit to the zeal, enterprise, and activity of the administration of the British Museum. But the satisfaction which so valuable an acquisition necessarily excites is not wholly unmixed. The investigation of truth is above and beside national predilection. The 'Bruniquel Cave' series is now divorced from the collections in France, of which it forms a complement, and upon which M. Lartet has been engaged since 1861, when he published his important researches on the Sepulture-Cave of Aurignac.

Those who take an interest in the advancement of our knowledge of the subject would have congratulated themselves if the Bruniquel materials had been placed in his practised hands, to be included in the work which he and Mr. Henry Christy are about to publish on the ancient remains of man of the 'Cave' period in France.

"One circumstance in the case deserves to be generally known. The instinct of a collector is to amass, hoard, and retain. Mr. Henry Christy is the possessor of one of the choicest private archæological collections in Europe. M. Lartet and he explored the Dordogne Caverns on a large scale, with the object—first of exhausting the ground, and next of distributing duplicates. They have presented huge slabs of the floor-matrix, containing embedded every variety of object, to all the principal museums in Europe, and selected sets to persons of all countries having a recognized position as labourers in the same field; and this, too, before their own researches were published. In their case a higher impulse extinguished the mere collector's instinct. No comment is required.—Sir, your obedient servant, H. Falconer.

"21, *Park Crescent*, *Portland Place*, *March* 10.

"P.S.—At the meeting of the Academy of Sciences (February 29) a note on the same and cognate subjects was communicated by the Marquis de Vibraye, who has laboured so meritoriously on the ossiferous caves of France."

On Some Foraminifera from the Tertiaries of Trinidad.—At page 38 of the 'Report on the Geology of Trinidad' is given a figure of a remarkable stratum of asphaltic rock. This stratum is nearly vertical in position, and projects from the cliff to some little distance into the waters of the Gulf of Paria. Though a considerable part of it has been removed since the drawing referred to above was made, it yet seems to possess a superior power of resistance to the encroachment of the waves than the remaining portions of the cliff. Upon a close examination the vertical mass is found to consist chiefly of the remains of Nummulites and Orbitoides, two genera of Foraminifera, whose shells, as is well known to geologists and palæontologists, form in various parts of the world thick masses of rock; the Orbitoides being generally characteristic of the Eocene period in the western hemisphere, while the Nummulites are regarded as indicative of the Middle Eocene in Europe and Asia. Here, however, we find the remains of both these generated in strata of supposed Miocene age.* *Nummulites* is regarded as a strictly Tertiary form of Rhizopod, while Orbitoides has been found in the Chalk or Upper Mesozoic deposits, as well as in the Lower Tertiary formations.

Of the *Orbitoides* vast numbers are contained in the San Fernando Tertiaries. They are found alike in the gypseous marls which constitute so large a portion of those deposits, and in the asphaltic portions of the group. In the marls they chiefly occur in the nodular concretions, and in the indurated veins and layers. In the singular mass of rock figured by Messrs. Wall and Sawkins, the Orbitoides seem to form the greater part of its bulk. They are not referable to any species of which I have seen figures. The Nummulites found in the same deposit present a decidedly close resemblance to *N. lævigata*, but the chambers seem to be, in the San Fernando specimens, larger relatively to the size of the whole shell. When a portion of the rock is submitted to heat, and the asphalte thus driven off, the Nummulites generally fall into two pieces, each of which presents a transverse section of the shell, showing distinctly the chambers which, during the life of the animal, contained its softer parts. Were it not for this circumstance, it might have been difficult to have obtained sections of these shells, as owing to their fragility they would scarcely bear the process of grinding down, however delicately conducted.

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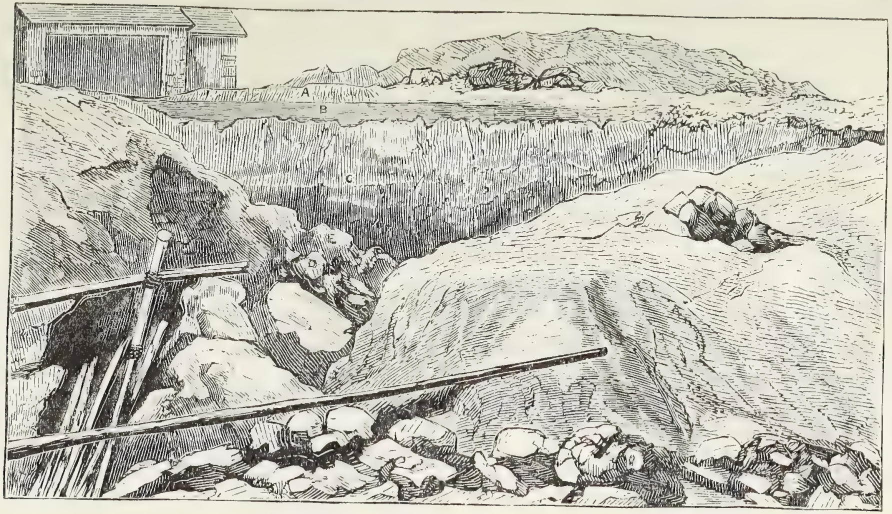
* Report on the Geology of Trinidad, pp. 35 and 162.

Some specimens of Bryozoa have occurred among the Orbitoides, but I have not succeeded in detaching a specimen. They are so brittle that the most careful manipulation is insufficient to prevent them from falling to powder under the hand of the operator. I have not detected any other organisms in the same bed as the Orbitoides and Nummulites; but both above and below it are found Tertiary fossils, probably not of more recent date than the Miocene age. I hope to be able to present observations on these fossils at some future time. Suffice it for the present to state that the evidence derived from them is not inconsistent with the presumption of the Miocene origin of the deposits in question. We know too little as yet of the Tertiaries of this part of the world to be able to pronounce a more decided opinion; but should the supposition of the Middle Tertiary age of the San Fernando Tertiaries be ultimately established, we should have here the remarkable phenomenon of the association of an Old-World with a New-World form of Lower Tertiary Rhizopod in a deposit of Middle Tertiary age. It would indeed be very possible, in that case, that the homotaxical representatives in Europe of the deposits at San Fernando may be found amongst the lower members of the Miocene group. But this observation would not necessarily extend to those portions of the Tertiaries which are found inland, at Mount Tamana, Jordan Hill, and St. Croix, for instance. The fossils from those places, as well as those from Manzanilla, and other parts of the east coast of the island of Trinidad, seem to belong to a somewhat later date.—R. J. LECHMERE GUPPY.

MISCELLANEOUS NOTICES.

The "Rules for Zoological Nomenclature," elaborated by the Strickland Committee of the British Association in 1842, have been reprinted in a pamphlet-form, under the authority of the British Association, by Messrs. Neill, of Edinburgh. The vagueness and uncertainty of the nomenclature of animals has been one of the greatest detriments to science, and before the framing of these rules was infinitely worse than it is now. Indeed, so long as naturalists take different views of the natural affinities of animals, there must and will be diversities of classification. The widest circulation and the universal adoption of this series of propositions will be the best antidote for the evils arising from still continued injurious practices. The object of the present issue is to get suggestions for the amendment and perfecting of the rules submitted to Sir W. Jardine and the new committee, before the next meeting of the Association in June.

The Proceedings of the Liverpool Philosophical Society contain—"The Ancient Fauna of Lancashire and Cheshire," by Dr. Collingwood; and "On a New Theory of the Generation of Steam, with an Explanation of the Geysers of Iceland," by Mr. E. J. Reed, H.M. Chief Naval Constructor; and "On the Manufacture of Stone-Implements in Ancient and Modern Times."



SECTIONAL VIEW OF STRATA AT SHIRLY QUARRY. By GEORGE MORANT, Esq.

THE GEOLOGIST.

MAY 1864.

DR. FRANKLAND ON THE GLACIAL ERA.

By the Editor.

Some of the novelties presented at the lectures at the Royal Institution have, from the hour they were spoken, taken rank with the discoveries of the age and the data of science; amongst such are some of the most important results of the researches of Davy, Faraday, and Tyndall. Others, as might be naturally expected, have risen to no higher rank than that of hypotheses or an hour's amusement, and after exciting some discussion and comment, have passed away into that oblivion to which all but fundamental or practically useful facts are, sooner or later, consigned. Amongst those familiar voices which we are there in the habit of hearing, few are listened to with more pleasure, profit, or instruction, than that of Professor Frankland, especially when he restricts himself to those branches of chemistry in which he is so eminent. The Glacial period and the former incandescence of the earth are two themes that geologists are eternally dwelling upon—whether with profit to themselves or with any advantage to their hearers it would be very difficult to say. For once Professor Frankland has left those realms of chemistry within which he is a monarch to run a lance at the same time both for and against geologists. Basing a theory on the supposed existence of an internal molten mass constituting the core of our globe, is taking for it about as secure a basis as any one might be presumed to have who attempted to balance his body at the top of a mountebank's pole, the other extremity of which was held by infirm and trembling hands. His body might be put in proper attitude and position, and duly manœuvred to acquire exactness of balance; but if the shaky hands gave way, the fall might be sudden and severe. The supposed fire-origin of granite was one of the original causes of the invention of the internal-heat theory; but modern researches have distinctly shown that certainly one at least of the petrological elements of that rock—namely, quartz—as seen now as a constituent of that very granite, never could have been subjected to the influence of dry heat. Another difficulty arises in respect to the internal molten state of our earth: if the core of our globe be in that condition, it would follow there must be internal tides, unless the solid crust of the earth were of immense thickness, and of a rigidity, at least, four times that of steel; for not less than that would suffice to resist the internal tidal tendency, taking the thickness of this crust as estimated by Mr. Hopkins. It is evident beyond question that a liquid mass, whether fluid at ordinary temperatures, such as the waters of the ocean, or rendered fluid by internal heat, must be equally subject to the laws of attraction; and consequently the moon would have an influence upon the internal molten core, as she has upon the external oceans.

Now, Professor Frankland—repudiating all the explanatory theories which have been hitherto given to account for superficial differences of temperature, from Lyell's different distribution of land and sea doctrine, to that of the higher elevation of all mountainous tracts during the Glacial age suggested by Professor Kämtz—based his new hypothesis on what he regarded as the incontrovertible fact of the internal molten fluidity of our earth. The descriptions of the fiords and the ice-scored land of Norway, which Dr. Frankland has lately visited, were exceedingly interesting and instructive; but when the Professor came to deliver his new hypothesis, we at once felt ourselves launched on the waves of an unnavigated sea, and saw many reasons why the bark of the adventurous *savant* should be deemed too frail for geologists to venture in. To say that the hypothesis was ingenious is only to give it its just meed of praise; to say it was substantial is quite another thing. It was this:—We are all familiar with the ordinary still. There is the boiler where the vapour is raised, the spiral tube in which it is condensed, and the receiver into which the condensed fluid falls. Compare the earth, its atmosphere, and its mountains to the still. From the ocean the vapour rises; "the atmosphere," says Dr. Frankland, "is the true condenser, for the aqueous vapour that rises in it to its utmost heights *radiates its heat* into space; the mountains are the receivers of the rain and snow precipitated." So far we have no objection to the doctrine. But to apply it practically to the production of the phenomena of the "Glacial period," which everybody knows was a geological period of intense cold, almost immediately preceding our own historical age, and possibly, according to recent ideas, absolutely including the early portion of the human era. Before this, according to the general tenor of geological notions, the earth had from the beginning of time possessed a gradually diminishing but still always higher temperature than it does at present; but whether this doctrine is not, upon stratigraphical evidences, open to grave doubts, we are by no means sure. Admitting this, for the sake of the argument, we have to see how Dr. Frankland applies Professor Tyndall's radiant-heat principles to the production of a *period* of intense cold.

The points which he deemed his theory must meet are thus stated. The glacial phenomena must extend over the *whole* globe; their occurrence must be of geologically *recent* date; they must have been preceded by ages during which glacial action was wanting; and they must be followed by a time during which there was a re-tendency towards an ameliorated condition of temperature. Moreover, Dr. Frankland considers it essential to show that during their continuance atmospheric precipitation was greater, and the snow-line lower, than at present. All these conditions, Dr. Frankland asserts, would naturally result from the gradual cooling of our planet; so that, according to his view now put forth, "the sole cause of the phenomena of the Glacial epoch"—or period of universal intense cold all over the earth—"was a former higher temperature of the ocean than that which obtains at present." Admitting that our globe was once so hot that all the water now in it was then *in nubibus* and not in the ocean cavities at all, he goes on to its first condensation into liquid, and then from the cessation of the boiling of the seas through a gradual diminution of temperature down to their actual state; a corresponding refrigeration of the land being contemporaneous. It was, he says, during the later stages of this cooling operation that the Glacial epoch occurred. For this result, however, he is constrained to the assumption that the earth and the sea-water have cooled at different rates. To prove this he brought forward experiments upon the differences of cooling between a cube of granite and one of water respectively heated to a given temperature, and then timed for the periods that elapsed in the giving out or radiation of the heat they had imbibed, for a reduction of ten degrees. These experiments we are so obtuse as not to see the corroborative force of, for it may be asked whether, if it take five times as much heat to raise one body to the same temperature as the other, we might not expect to find one body proportionately longer than the other in parting with the heat it had obtained. It seems to us that the experiments would have been more to the purpose if a mass of molten lead had been covered by an iron-bottomed trough of water, in which a given mass of granite soldered down to the intervening iron plate had been partially immersed. Such, at any rate, would have been conditions more nearly resembling those presumed for our earth.

Of course, the nebular hypothesis of the formation of stellar globes from the condensation of vaporous matter in space, and the evolution of light and heat in the process, was brought in as the primary origin of the presumed internal molten state of our earth; but it will be well to bear in mind that our largest telescopes have resolved, one after the other, the numerous luminous patches in the vast heavens into gigantic clusters of sun-stars, and that up to this moment there is no proof whatever of any former nebulous state in our own or any other solar system. Nor was the oft-quoted nebular hypothesis the only support Dr. Frankland tried to get from astronomy. He has been searching the moon for more than a year with a reflecting telescope of 7 inches aperture, and has found *two* streaks on her surface, which he thinks may be the marks of glaciers with their terminal moraines. One of these fancied moraines is at the termination of that remarkable streak which commences near the base of the gigantic crater Tycho, through the ring of which it breaks,—a fact not omitted in Dr. Frankland's illustrating diagram, and which would alone much more naturally assign its origin to the class of volcanic phenomena. The other extends from Rheita, the crater-rim of which is also broken down, as it would be by the passage of a lava-stream. But as the author of the new hypothesis admits that, "with regard to the probability of former glacial, or even aqueous, agency on the surface of the moon, difficulties of an apparently very formidable character present themselves," we need not pursue further these lunar fancies—for such we cannot help regarding them.

It will naturally occur to those who are not familiar with ice-making machines, that if warmer water in the sea will produce a universally colder climate, and an equally wide-spread lower descent of the line of perpetual snow on our mountains, that when the sea was boiling, and the evaporation yet more abundant, the colder still should have been the condition of our planet's land-surfaces, until, in fact, the snows of the land should have touched the waters of the boiling ocean, and have melted only on the margins of its shores. This argument would indeed have been viewed as the *reductio ad absurdum;* but the Professor does not bring us quite to this dilemma. He presumes the radiant heat of the earth was sufficient to drive outwards the upper atmospheric sphere of radiation and condensation far above and beyond the loftiest mountains. We give the conclusions to which these speculations lead their author—namely, "that a liquid ocean can only exist upon the surface of a planet so long as the latter retains a high internal temperature." "The moon becomes thus," he says, "a prophetic picture of the ultimate fate which awaits our earth when, deprived of an external ocean, it shall revolve round the sun an arid and a lifeless wilderness." A not very comforting prospect truly, which we doubt not will be very long indeed before it commands popular assent.

ON REMAINS OF THE *MEGACEROS HIBERNICUS* IN GYPSUM IN IRELAND.

By David Leslie, M.D.

The "Irish Elk" has been hitherto only found in the shell-marl underlying extensive turbaries. It is a true deer, intermediate between the fallow and rein-deer. In England it has been found in lacustrine beds, brick-earth, and ossiferous caves (Owen). The subject of the present paper is a dorsal vertebra belonging to a skeleton quite as large, if not larger than the specimen in the College of Surgeons Museum, London, with which it was compared. It was found on the Shirly property, in a bed of gypsum, county of Monaghan, Ireland. This gypsum-bed is very extensive, being many square miles in extent, underlying the glacial drift, embedded in and sometimes alternating with a fine ferruginous clay. The subjacent rock is the older or lower coal sandstone, which lies unconformably on the mountain limestone, which reposes on the Silurian, the latter forming hills of 500 or 600 feet elevation in the immediate neighbourhood. The surface-soil is formed of ancient drifts of different ages, the one containing enormous blocks of mountain limestone, the other, the older, more compact, and containing small fragments, very rare, of a limestone, which, from comparison, is supposed to have been brought from the counties of Tyrone and Fermanagh, by a current that denuded all the western aspects of the Greywacke ranges of hills, producing very markedly the phenomena of "crag and tail," which are there to be seen in endless examples.

On the summits of many of the drift-hills are found some enormous blocks of mountain limestone, evidently deposited from floating icebergs, which ran aground in the shallow waters as these hills emerged from the deep, and there deposited their gigantic burdens as the ice melted away.

The accompaning sketch (Pl. XI.), made by George Morant, Esq., Shirly House, gives the true relative position of the fossil. The vertebra was found embedded in gypsum, about 1 foot below the surface of the gypsum rock. The section in the plate gives—alluvium 2 feet; peat 1; glacial drift 6; gypsum 1 foot; then the vertebra in the rock, which extends downwards to a thickness of 40 feet. Thus we find an unquestionable vertebra of *Megaceros Hibernicus* embedded in solid gypsum, of an age much older than any glacial drift. The total absence of fossils in the ferruginous clay and gypsum, which are of contemporaneous origin, made it impossible to give any other than a stratigraphical age to the bed, in which the vertebra was found, it being placed beneath the oldest drift and lying on the lower coal-sandstone. The Irish Elk is therefore of much greater geological antiquity than what has been hitherto supposed.

Tunbridge, April 2, 1864.

NEW SPECIES OF TEREBRATELLA, FROM THE BARGATE STONE.

By Mr. C. J. A. Meyer.

I send some drawings and a short description of a pretty little Brachiopod from the Lower Greensand of Godalming, of which, unfortunately, I possess at present only a few single valves, viz. 7 dorsal and 4 ventral valves. These are, however, sufficiently perfect to enable me partially to describe the shell, and I take the present opportunity of so doing, with the hope that, at some future time, better specimens may come to light. (See Pl. XII. Figs. 1–6.)

The species is apparently new, local in distribution, and, so far as I am at present aware, confined to the "Bargate stone" of Guildford and Godalming, the position of which is near the base of the ferruginous or upper division (of Fitton) of the Lower Greensand. From the partial outward resemblance of this shell to that of *Terebratella Menardi*, and from the fact of the hinge line and medial septum in the dorsal valve being of the same form in both, I am inclined to consider this species as a Terebratella: the peculiar form of the dorsal valve has suggested its specific name.

Terebratella trifida, n. sp. Shell (judging from a comparison of several single valves) as wide as long, in old specimens perhaps rather longer than wide; convex in both valves: dorsal valve moderately convex, and divided into three portions; a large, elevated, mesial fold, in the shape of an acute rib, occupying the entire central division, on either side of which, on the lateral divisions, there exist one or two ribs of small elevation, followed occasionally by a third of still smaller size; the whole being crossed by numerous concentric, strongly marked lines of growth. The hinge line is but slightly curved.

The ventral valve is much deeper than the opposite one, has a deep angular sinus, and on each side of the lateral portions of the valve, two or three ribs; the beak seems to have projected but little, in one of my specimens appearing to have been truncated almost as abruptly as in *T. Menardi*, and showing evidence of a small flattened space or hinge area between its ridges and the hinge line: the foramen is rather large.

The interior of one of the dorsal valves exhibits a small, elevated, longitudinal septum, commencing from beneath the hinge plate, and extending to nearly half the length of the valve. Shell-structure punctuate.

Dimensions.—The largest dorsal valve in my possession measures

Approaching most nearly in form to *T. Menardi*, this species is, however, readily distinguished by its very large and simple mesial fold.

The two first examples of this shell I obtained from a small quarry near Tewsley, south of Godalming; the others are from a quarry about a quarter of a mile west of St. Katherine's Hill, near Guildford, where it occurs in company with *T. Menardi*, Lam., *T. oblonga*, Sow., and *Terebratulina striata*, Wahl., var. (*T. auriculata?*, D'Orb.); these are, however, all extremely rare.

8, *Church Buildings, Clapham Common.*

EXPLANATION OF PLATE XII. [No plate]

Fig. 1. Dorsal valve, magnified; 4. Front view of ditto; 5. Another dorsal valve; 6. Interior of ditto, with medial septum; 2. Ventral valve; 3. Ditto, side view.

CORRESPONDENCE.

Geological Plagiarism.

The following copy of a letter published in the 'Reader,' has been sent to us for insertion :—

"Geological Plagiarism.—To the Editor of the 'Reader.'—Sir,—Under this head I observe a letter in the last impression of the 'Reader,' which is by no means flattering to myself, and I would therefore now beg to make a few remarks by way of explanation. 'F. G. S.' is not incorrect in supposing that he 'had seen the same ideas, and possibly some of the same expressions, not long before in the Memoirs of the Geological Survey.' I acknowledge the similarity of idea in the passages quoted by him, and the sameness of expression of which, in one or two cases, as a student and a beginner, I have been unfortunately guilty, and which, but for an oversight, would have been indicated by inverted commas. But when I show how that has arisen, I hope 'F. G. S.' will understand my excuse; and should this meet the eye of Mr. Geikie, that that gentleman will accept my apology. On reading over, some time ago, the Geological Survey's Memoir on Edinburgh, I was struck with Mr. Geikie's remarks on 'Denudation' in chap. xiii., which, by the way, applied to Midlothian generally, and not to Arthur's Seat in particular. The idea which more especially attracted my attention was that Midlothian had been subjected to a process of denudation at two different and widely-separate periods in geologic time, and as I happened to be studying the geology of Arthur's Seat at the time, I naturally desired to have a clearer idea of the effects of denudation on that particular hill. The result was the paper in question, which, as you can easily imagine, was written in the spirit of Mr. Geikie's remarks, but at the same time with the desire to give greater prominence than he has done to the idea above-mentioned. The *plan* of my paper is quite different from the chapter in the Memoir, and is all I ever intended to 'be regarded as original.' I certainly ought to have mentioned the source from which I had gathered a portion of my information, and herein I confess I have made a mistake; but at the same time 'F. G. S.' and Mr. Geikie will remember that these ideas on the denudation of Midlothian are by no means new, but have been more or less entertained by our local geologists for some time back, and have even been made the subject of papers before the Edinburgh societies, as my own was before its appearance in the pages of the 'Geologist.'—I am, Sir, yours respectfully, James Haswell.

"*Edinburgh*, 23*rd March*, 1864."

The Eternity of the Universe; in Hebrew Phraseology, of the Heavens and the Earth.

Sir,—After many years' reflection upon the subject, I have come to the conclusion that the true Scriptural doctrine—which at the same time commends itself to reason—is, that the universe (in Hebrew phraseology, the heavens and the earth) is eternal; in other words, that as there always has been and will be a God, so there always has been and will be a universe,—in Hebrew phraseology, an earth and heavens. I have come to the opinion, that where geology ends, there the Mosaic record begins. This interpretation is exceedingly simple, and removes all difficulties. We have only one question to deal with, and that a very simple one, namely, does the Mosaic record on the one hand, and geology on the other, testify to the same condition of the earth at the only point where they come in contact? This question can be answered in a few words.

Moses says, "In the beginning God created the heavens and the earth. Now the earth it was a wreck and a ruin; and darkness (was) upon the face of the deep; and the spirit of God (was) hovering over the face of the waters."

The meaning of these words will be best seen in the following paraphrase:—

"The following is the true history of the creation of the heavens and the earth:—They were created by God, and they were created in six days. At the time when their creation commenced the earth was in a truly deplorable condition. It was a wreck and a ruin. The ploughshare of ruin had passed over it, leaving it waste and desolate, dark and damp. Murky vapours ascended from the abyss of waters, effectually shutting out the light of day. Being deprived of light, the earth was destitute of heat; consequently animal and vegetable life was extinct. The Spirit of God regarded the earth in this its desolate condition with tender solicitude, even as a mother-bird hovers over her young when in misery and pain."

According to the exposition of the learned commentator Macknight, 2 Pet. iii. 5, 6 is a parallel text, referring to the period of the Drift, or, as it is sometimes called, the period of alluvial and diluvial deposits:—"By the word of God the heavens were of old, and the earth standing out of the water and in the water, whereby (that is, by which heavens) the world that then was, being overflowed with water, perished."

Such is the testimony of Moses and the Apostle Peter.

What says geology? While I am writing, a voice is heard from the mountains on the other side the broad Atlantic, attesting the truth of the Biblical record. I quote the following paragraph from the 'London Journal,' March 19, 1864:—

"*The Earth made Cold by Heat.*—Professor Agassiz lately delivered a course of three lectures in Boston, U.S., and the greater part of the last one was devoted to a description of the phenomena which indicate that the continent of North America had at one time been overlaid by dense and unbroken masses of ice, moving from the north to the south. The traces of such an agency are found in the peculiar drift deposited on the surface of the continent, from the Arctic to the 36th or 40th parallel of latitude, being in its nature and composition such as would be deposited by immense cakes of ice, pushing forward the débris of the soil over which they moved, and bearing on their top the irregular masses of stone which are found in the region designated. That the direction of this moving mass of ice was from north to south is proved by the abrasion of hills having an acclivity facing towards the north, where the southern descent is without such characteristic marks. After stating the grounds on which the 'earthquake theory' was inadequate to explain the phenomena of this drift, Professor Agassiz estimated that the ice which deposited this drift and produced its other attendant phenomena must have been 5000 or 6000 feet thick. But whence came the cold which produced such a thickness of ice? This query was answered by supposing that there had been injected into the sea, from the subterranean fires of the earth below it, a vast mass of melted material, thus producing an immense volume of vapour, which, escaping for ages into the upper air, was condensed, and fell in the shape of snow and hail. By this mass of snow and hail the temperature of the earth's climate was reduced from the comparative warmth which preceded it, even in Arctic regions, and the world entered on '*the cold period*,' which it was the object of the lecturer to describe and to account for while describing. Professor Agassiz said that *this was the winter which preceded man's advent in the world*."

Is not my point made out? Is not the *thohu* and *vohu* of Moses identical with *the cold period*, *the winter of the world*, of Agassiz? Surely there can be only one answer.

It seems almost superfluous to refer to the boulders which are found in Norway and on the coasts of north-western Europe, which evidently belong to the period of the Drift, and which have been borne to the spots where they are now found on moving ice.

I think, Sir, your readers must allow that my point is clearly made out, namely, that Moses and the geologists are of one mind as to the deplorable condition of the earth at the time when the Mosaic record and geology come in contact. I have the honour to remain, Sir,

Your obedient servant,
FREDERICK FYSH.

Walgrave, April 7, 1864.

P.S. I take the meaning of the fourth day's creation to be, that the sun, moon, and stars, which had been previously obscured, then became visible. Henceforth the earth was to receive light from those luminaries, and not to be supplied with miraculous light, as on the first day.

The Scottish Pteraspis.

Dear Sir,—If not occupying too much space, I would feel obliged by your inserting in an early number the following remarks on the communications in your numbers for March and April from the Rev. H. Mitchell and Mr. E. R. Lankester; these I have the less hesitation in offering, as, while fully appreciating the value of the criticisms of one who has done so much towards adding to our knowledge of this genus as Mr. Lankester, I can at same time fully corroborate the correctness of Mr. Mitchell's restoration, in his interesting letter, in almost every particular.

In a former letter (Geol. Feb. 1863) I had occasion to remark that Mr. Lankester, in a notice (Dec. 1862) of a former and much less correct restoration of our Scottish Pteraspis by Mr. Mitchell (Nov. 1862), had not made sufficient allowance for probable specific difference of form. I must here state my belief that the same mistake has again occasioned some of Mr. Lankester's remarks in his last letter. I had recently an opportunity of inspecting Mr. Mitchell's series of specimens of this fish, and of comparing them with my own. They all undoubtedly belong to the same species, and are in my opinion distinct from *Pteraspis rostratus* and other English species.

The only points in Mr. Mitchell's latter restoration which appear to me scarcely correct are, that the breadth seems rather exaggerated, and that the posterior margin is represented as formed of straight lines, while it consists of a double curve, concave posteriorly. The lateral posterior angles are produced, forming well-marked but very short cusps, pointing backward and slightly outwards. From this and also from the well-marked and finished lateral outline of the posterior head-plate, I think it extremely improbable that this species ever possessed the lateral small plates forming the cornua of *Pteraspis rostratus;* certainly none of the many fragments in our collections show any vestige of these. One of my specimens has the occipital spine *in situ*, and in several of Mr. Mitchell's the spine is shown detached; thus differing from the occipital crest of Cephalaspis, which forms an integral portion of the head plate. This spine is short, stout, striated longitudinally, and is deeply inserted in the substance of the head plate, in which it seems to have been inmovably fixed. In their composition the head-plates are quite similar to that of the English species, some of Mr. Mitchell's specimens having, as noticed by him, the exterior striation, the internal reticulated markings, and the inner nacreous plates or lamellæ well preserved. From his specimens I have little doubt that the perforations at *b*, in the figure given in your number for March last, are indeed the eye orbits; while those at *a* are too distinctly marked to have been the result of accidental fracture, whatever may have been their nature. As drawn in Mr. Mitchell's latter restoration, and in my figure (Geol. Feb. 1863), the test consists of only two distinct plates, an anterior and posterior, with a distinct spine.

No light has yet been thrown on the nature of the under surface of the head, some of our many fragments may possibly belong to this part of its body; to me, however, they all seem mere broken fragments of the upper cephalic plates.

As to the oral appendages, until very recently I was of opinion that these were of the nature indicated in Mr. Lankester's letter, both in this genus and in Cephalaspis. This opinion was founded not only on negative evidence, but also on the form of the plate protecting the under surface of the head of the latter genus, and in my letter referred to (Feb. 1863) I expressed this conviction pretty strongly. During the course of last autumn, however, I had the good fortune to open out some magnificent specimens of *Cephalaspis Lyelli*, in which the position and character of the mouth and teeth are distinctly exhibited. The mouth opened immediately under the cephalic plate, the gape occupying about one-third of the entire outer margin, the upper maxillæ, or jaws, anchylosed with the cephalic plate, forming an integral part of it, and are finished with a single row of short, stout, slightly flattened teeth, which extend quite round to the cornua or cusps. In one of my specimens, a portion of the lower jaw is preserved with its single row of similar teeth. From the decided analogy between Cephalaspis and Pteraspis, it is probable that the latter had been similarly provided. One of Mr. Mitchell's specimens seems to bear this out, having, as noticed by him, the anterior margin of the anterior plate turned downwards and inwards, as in all our moderately well preserved heads of Cephalaspis. The analogy between these genera is further confirmed by Mr. Lankester's most interesting discovery of the scales of Pteraspis, stated by him to be similar to the dorsal series of Cephalaspis,—meaning, I presume, the bony rings covering the body of this creature. These, however, my specimens show to have been again covered externally by scales similar to those covering the cephalic plate.

It seems to me that as yet the nature of the Cephalaspidæ is very imperfectly understood. I strongly suspect the cephalic plate to consist of the various cranial bones anchylosed, while the bony rings protecting the body equally appear to represent the vertebræ and ribs; all covered externally with scales, or rather dermal scutes, thus indicating that this family may have held among the fishes a place somewhat, although by no means exactly analogous to that held by the Chelonians amongst the more highly organized reptiles. Much careful investigation is necessary, and still more perfect specimens are required before this can be fully wrought out.

It is right here also to state that to Mr. Mitchell belongs the merit of first discovering Pteraspis in our Scottish rocks, although it is only very recently that I was aware that he had procured and recognized fragments of this fish some time anterior to my discovery of its remains. Believing our Scottish Pteraspis to be specifically distinct from the other species yet found, in a paper which I hope to have the honour of communicating at an early meeting of the Geological Society of London, noticing it along with some other Forfarshire fishes, I propose his name as a specific affix for it, and that it should be known as *Pteraspis Mitchelli*.

I am, dear Sir, Yours ever truly,
James Powrie.

Reswalla, April, 1864.

Spiral Planetary Orbits.

Sir,—Your highly suggestive article on "Spiral Planetary Orbits" (*vide* 'Geologist' for March) gave rise to some ideas which may prove interesting to those of your readers who are partial to speculative inquiries.

The generally accepted explanation of the planets' translatory motion is, that those bodies were projected *once for all* into free space with great velocity, and that as they meet with no resistance they will always continue their course.

The existence of free space here assumed, is, however, very doubtful, since we can hardly reconcile a perfect vacuum with the transmission through it of light and heat, for we know of no such thing as physical force existing independently of matter. But, as you have already shown, if matter does occupy space, then, however rarefied it may be, there must be resistance, friction, and consequently retardation of planetary motion. This slackening of the speed, by destroying the equilibrium of the centripetal and centrifugal forces, would contract the orbits, and ultimately cause the planets to fall into the sun. The equilibrium of the two forces once destroyed, both the decrease of speed and the increase of attraction would tend to the same end, and the motion towards the sun would be so continuously and immensely accelerated that the final catastrophe would not perhaps be so far distant as might at first be imagined.

To such a view of planets revolving in a plenum, without any supply of motive force but that first acquired, some difficulties present themselves, not the least of which is, that if the results of retarded planetary movements are expected to evince themselves in the future, they may also be looked for at present, as phenomena indicative of such retarded movements during time past; for we know not, neither can we imagine, what proportion the past bears to the future.

But can we discern any such phenomena? Not in the planetary circuits, for the centripetal and centrifugal forces still appear to balance each other, their equilibrium remains undisturbed, and we do not find that those planets nearer the sun have a decreased orbital velocity. On the contrary, for "the angular velocity of a planet's movement in its circuit is inversely as the square of its distance from the sun."

How, then, can we reconcile the continued regularity of planetary motion with the existence of a resisting medium in space? Does it not appear as though we should have to discard the "projected once for all" hypothesis, and assume the existence of a sustained or continually acting motive power?

Then, recalling to mind the correlation of the physical forces, and viewing heat and the other forces as directly or indirectly convertible into their equivalents of motion, we are induced to ask, may not force emanating from the sun be the sustaining cause of planetary centrifugal motion? Here we should have a continuous supply of force, which, by counteracting the centripetal force and the resistance of ether, would prevent any contraction of the orbits. Moreover, by such means, we could understand how it is that planets nearer the sun have a greater velocity than those more distant, for the increase of heat and consequently of velocity they received would be equal to the increase of attraction, and heat, velocity, and attraction would all be inversely as the square of the distance of the body from the sun. This we find to be the case.

According to such a view, our journey around the sun would only cease when that luminary failed to supply the necessary amount of force. But, were the sun to become dark and cold, no life could exist on our globe, no changes could take place in the conditions of matter, there could be no liquids, no gases, so that the contact of earth and sun at such a time would be the collision of two dark, gloomy, silent, lifeless masses of inert matter.

The revolution of satellites around planets, as for example that of the moon around the earth, might perhaps be accounted for by supposing the earth's motion (which we cannot believe to be wasted), converted into frictional heat at the surface, which, together with the moon's heat, might act as sufficient centrifugal force to counteract their mutual attraction. The moon's revolution, in conjunction with the earth, around the sun would be perhaps the result of that luminary's heat or force acting on planet and satellite as a connected system.

The greatest difficulty which presents itself to the view of solar force producing motion is the fact that we only know heat as a molecular force. But M. Faye, in the 'Comptes Rendus,' supposes the existence of a repulsive force exerted by the sun, not to be expressed by attraction with a negative sign prefixed, but bearing the same relation to molecular repulsion as celestial attraction does to terrestrial attraction.

Lastly, let us call the comets into the witness-box, and see what those eccentric individuals have to say on this subject. In an article entitled "Cometary Phenomena" ('Intellectual Observer,' 1863), we find the following:—"It is evident that the whole of the mass is vehemently acted upon by some influence emanating from the sun, the continuation and accumulation of which, after the perihelion passage, seem to point to a calorific rather than a more instantaneous electric or magnetic action." Again, Mr. Marsh, in writing of comets in the 'American Journal of Science and Arts,' attributes the peculiar character of cometary matter to the extreme and violent changes which it undergoes in its rotation around the sun. Halley's comet, for example, at one time approaches the sun to within 56 millions of miles, and then recedes to the enormous distance of 3370 millions of miles. At the time of its perihelion, or least distance, it passes through one heliocentric degree of its orbit in 15·7 hours, and receives in a given time 3600 times as much heat as when it reaches its aphelion or greatest distance, in which position its motion is so slow, that six years and a half are required for its passage through one heliocentric degree. Thus, it will be seen, that comets with eccentric orbits are subject to violent changes of temperature and velocity which do not affect (to such an extent) planets whose orbits approximate more closely to the circular form.

In conclusion, it may be said that in the absence of a continuous supply of motive force, it is quite as difficult to reconcile a plenum with planetary regularity as a vacuum with the transmission of light and heat.

I am, Sir, yours obediently,
JOHN PENTECOST, F.C.S.

London, April 6, 1864.

COLONIAL GEOLOGY.

LEAVES FROM MY AUSTRALIAN NOTEBOOK.

BY THOMAS HARRISON, OF MELBOURNE.

NO. I.—CAPE SCHANCK, ITS BASALTS AND CAVES.

This spot, although barely, as the crow flies, fifty miles from Melbourne, is not easy of access. Its bold, precipitous, and iron-bound coast-line offers no harbours; the district boasts of neither town nor township—an Australian name for a little village, just as a city in America may mean half-a-dozen tenements,—a few farmers till the rich soil of the neighbourhood, and some three or four squatters have stations thereabouts; the traffic between such a place and the metropolis is small, and on its not altogether bad roads coaches are unknown. To proceed thither one must take his own or hired horse or vehicle, or he must go on foot. Adopting the latter alternative, the better plan will be to land at Schnapper Point or, supposing the steamer should be running, at Dromana. This, the last township on the route, is composed of some two or three houses, as many hotels, and a long pier, built apparently to accommodate the latter. Close adjacent, and the principal landmark near, is Arthur's Seat, a hill or mountain of some thousand feet in altitude. This consists of a central granite mass, surrounded by Tertiary, Silurian, and Basaltic rocks. The ascent is easy and the height by no means great, but being situate on a sort of peninsula, the view from the mountain top is extremely fine, embracing, as it does, an extensive panorama of Western Port, Port Phillip, Bass Straits, and in one direction the vast spread of still uncleared land lying between the seacoast and the Australian Alps.

In visiting the spot I was unable, during the short time at my disposal, to detect traces of the Tertiary deposits having been in the least disturbed, so that, although the surface of the adjoining district appears to have been alternately raised and submerged several times, the changes must have been brought about by movements in which the older granite and the newer strata alike participated. Descending from the mountain, the road lies for some miles further along the coast of the adjacent bay. In this part of the journey very little of the picturesque presents itself, the student of geology may, however, see in some measure how rocks are formed, by a careful contemplation of the numerous sandbanks running along the shore; and may, moreover, chance to find, stranded upon the beach, more than one specimen of that representative of a bygone age, so interesting to the student of oolitic and cretaceous fossils, the *Cestracion Philipsi.*

Leaving the beach, in order to cross the peninsula at its narrowest part, the bush track to be followed leads over an extensive limestone district and an immense number of little hills, called locally "cups and saucers,"—a name derived from each hillock resembling a sort of rounded cup or basin turned upside down. A more tame or dreary bit of scenery can scarcely be imagined. In the valleys it is impossible to see twenty yards before you, and on the higher portions of the ground you see nothing but the eternal round-topped hills, each so like its fellows, that, supposing the sun does not shine, one is certain to lose his bearings unless the compass is constantly studied. What trees there are appear stunted and deformed, and in summer the scrub below is either parched up by heat or blackened by bush-fires. Ever and anon you come across a dilapidated hut, used, in the days of building speculation or a dearth of coals, as the abode of either a lime-burner or a wood-cutter; but there is nothing very pleasing in the spectacle. Of streams of water there are none, although springs are said to be readily found at a very moderate depth. Being once lost hereabout for eight hours, with an empty pocket-flask, an unpleasant reminiscence of a recent breakfast on salt meat, and beneath the parching sun of an Australian summer, I have a most vivid recollection of the locality, and the particular joy experienced when, like the soldiers of the old Grecian general, I was able to cry, "The sea! the sea!" and survey from the last dry "cup and saucer" of the set or series the fine spectacle of Bass Straits rolling its giant waves lazily on the beach.

The first thing striking the tourist on the Straits side of the peninsula is the number of sand dunes everywhere apparent. These are still in process of formation, stretching with a gentle slope towards the sea, presenting a tolerably steep escarpment inland, looking the very pictures of desolation, bare as they are of all herbage, save where a few sand-reeds have taken root, or where some already half-buried tree stretches its few leaf-covered branches above the drifting sand.

The limestone hereabout is remarkable for containing numerous concretions shaped like branches and roots. Settlers in the neighbourhood declare these to be petrified trees, long since buried as before described; a belief in some degree borne out by the large number of trees seen to be, more or less, completely covered up in all directions by the ever-moving hills. Certainly the resemblance to petrified trees is exceedingly great, and down the centre of more than one of these bodies I have myself found running a small portion of decaying wood; so that if the ligneous substance does not actually petrify, it may act as a sort of conductor, whereby water is guided through the mass, cementing, in time, the grains of sand and comminuted shells into a stone harder than the surrounding rock.

The wide extent of sandy beach and the friable nature of the limestone is hardly favourable to the development of very precipitous cliffs, and generally, even where the coast is highest, the ground slopes with tolerably steep descent towards the sea. After a time, however, a singular change in the cliff formation is apparent. A jutting headland is distinctly seen, in the distance, presenting its lowermost and basement stratum to the waves as a straight and perpendicular wall of rock, whilst higher up there is the formerly observed sloping portion, the whole looking somewhat like the edge of a plank bevelled to the extent of half its thickness. This appearance is the natural result of the lower portion being basalt and the upper being limestone, similar to that before described. This cliff, composed of these two strata, rises in some places to nearly two hundred feet. Cape Schanck itself, a projecting tongue of land, is nearly of this altitude, and is surmounted by a lighthouse bearing its name, and towering upwards for another fifty feet.

Generally speaking, the cliffs are nearly impracticable for either ascending or descending, but immediately eastward of the Lighthouse Point the basalt suddenly dips, and the bottom of the limestone being but little above the sea-level, a slope is formed, by means of which descent is a matter of but little difficulty; scrambling down this, the spectator finds himself in a little cove—dry, save during storms from the south-west—and which, from its cindery appearance, might be a sort of vestibule to Tartarus. At one place, where the cliffs are most perpendicular, is seen a small opening, which, explored, turns out to be the entrance to a cave, from whose roof depend immense stalactites of fantastic forms. It often happens that caves in volcanic rocks are the result of a fault, consequent on two streams of molten matter meeting and forming an imperfect joint; but the cave under consideration apparently owes its origin to a soft strata of basalt (presently to be alluded to), which being eaten away by successive tempests and the percolation of land-springs, has left the cavity as at present. The stalactites are simply a deposition of lime gathered by water gradually filtering through the limestone stratum by which the cliffs are surmounted hereabout.

The force of water driven into waves by continued storms may be studied here with great advantage. Looking out from this solitary inlet, as sea after sea comes tumbling in, the scene is grand in the extreme. Rocks such as Martin loved to paint as foregrounds to his pictures, are here seen, alternately white with foam or black as some huge sea-monster shaking his dripping sides above the brine. Nor is the beautiful absent in this sequestered spot. In sheltered nooks sea-anemones spread out their flower-like tentacles, and troops of tiny, brightly-painted mollusca crawl lazily over the sea-washed boulders. Adown in crystal pools, left by the retreating tide, appears a bottom thickly covered with seaweeds of a hundred hues. Looking at these, one starts, perhaps from their propriety, a body of migratory crabs, who take tremendous "headers" downward into the limpid water, and hide in sore affright mid groves of fucoids.

Just out at sea, beyond the slanting tongue of limestone by which the descent has been made, stands a solitary pillar of basalt fifty feet in height, and known as the pulpit rock. In these days of iron-clads and cupola-ships, looking at the mass from one point, it is not difficult to associate its peculiar form with that of a huge, half-submerged battery with a single turret. The mass of limestone, too, close adjacent, bears no slight resemblance to the iron-roofed 'Merrimac.' Seen together, these two objects might reasonably be taken for the 'Monitor' and her famed antagonist, which, meeting in deadly strife, were going down head first beneath the billows.

Along the whole range of coast from the above spot to Western Head are scattered evidences of phenomena interesting to the geologist. In one spot a spring, after percolating the limestone rock and bubbling out from beneath the foot of the cliff, coats the shingle with calcareous sinter, and forms a conglomerate of basaltic pebbles, shells, and corals; in another, masses of seaweed drifting ashore with stones entangled in their roots, show how portions of a distant rock may be transported and eventually dropped on some deep sea-bottom where currents are unknown. Here there are caves large enough to hold a hundred smugglers, and close beyond a natural arch that might have been built by gigantic Titans; a little further, and there is a basaltic stack rivalling a cathedral in dimensions, or a lofty pillar, poised on a slender base, rears itself in some sheltered bay.

Near Western-Port entrance, the basalt dips downwards into a sort of basin, in which a whitish Tertiary rock, looking at a distance like chalk, but very different in appearance from that rock when closely examined, has been deposited, and is literally built up of spines of Echinidæ, shells of mollusca, and the broken carapaces of large crustaceans. The whole of these remains, with the exception of the spines, are much broken; the latter are so well preserved that youths in the neighbourhood collect them to use as slate-pencils: for such a purpose they answer most admirably.

About a mile westerly from this rock, the upper portion of the basalt having been denuded down to the water's edge, a pavement of hexagonal and pentagonal blocks is displayed. These, the blocks, are of such regularity as to resemble a work of art rather than one of nature. Here, as in most portions of the district along the coast, the basalt is arranged in a manner which resembles stratification. First of all, at the sea-level, or near it, is a compact rock, sometimes columnar, although from its low level this feature is not particularly noticeable, unless, as in the case above cited, the ends of the columns are laid bare; next there is a thin bed of red-ochrish clay, comparatively soft and friable; and above, forming the summit of the cliffs, save where the limestone appears as a capping, is a thick mass of basalt, only rudely, if at all of a columnar structure.

No idea can be formed of the extent downwards of this lower bed, it never having been passed through. The thickness must, however, be considerable, since basalt only assumes a crystalline form when collected and cooled in large masses.

As a rough guess, I would suggest that the entire formation is the result of at least two outbursts of molten material, and that the clayey stratum referred to had collected either as scum and scoriæ arising from the molten matter, or as detritus deposited thereon by aqueous agency. Over this the upper basalt was afterwards poured out. Subsequently the district sunk beneath the sea, allowing Tertiary rocks, after covering the whole, to be deposited; last of all, the formation was raised to its present level, and the process of denudation commenced.

This denudation would be greatly facilitated by the existence of the soft layer just referred to. On this the waves, as they do at present in eating out caves and arches, would act successfully. Once undermined to any great extent, the fall of large portions of cliff would be a matter of certainty, and strewn upon the beach as boulders and shingle kept in motion by successive surges, every fragment would act the part of a muller grinding and being ground to powder; thus the talus would be cleared away, and the sea would be permitted once more to eat away the soft and yielding stratum.

Reflecting upon these phenomena, the mind is naturally astonished at the idea of a sea of molten materials stretching over an area of fully two hundred square miles. Nor is the subsequent wasting away and denudation by waves and ocean currents, to the extent which becomes evident by a merely casual observation, one whit less startling. Basalt similar in mineralogical character, and of like geologic age, forms the surface-rock of Philip, is covered by a thin capping of Tertiary deposits in French Island, and overlies the Carboniferous strata on the adjoining mainland near Griffith Point. No one examining these several basaltic masses can doubt of their having been once continuous. The various channels leading to the ocean, together with the greater part of Western Port Bay itself, must have been literally cut out by the continual influx and eflux of the tidal wave. Some of the difficulty may be avoided by supposing a soft strata undermined by the huge breakers of the Pacific, as previously alluded to, but even then the time necessary for accomplishing the required result almost surpasses belief. Shingle in every stage of formation from fine sand to angular boulders, huge landslips whose fall must assuredly have been of comparatively recent date, and rocky masses so undermined as to render their speedy crumbling into a mass of detritus a matter of certainty,—all point to the same conclusion, that the disintegration of the indurate material has been solely the result of aqueous agencies long continued. Still, both theory and fact alike declare the immensity of the period required to bring about the changes witnessed. The colonist remembers the shingly beach as ever shingle; the mass of talus seems to have undergone no visible change; and the rocks, whose bases are undermined, and whose stability thus seemingly destroyed, appeared just as near their dissolution when some adventurous circumnavigator left his vessel in the offing, and landed hereabout for the first time some century ago.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

SCHOOL OF MINES.—DR. PERCY'S LECTURES ON CHEMICAL GEOLOGY.

Lecture III., *December* 17, 1863.—At our last meeting attention was especially directed to the subject of alumina, a base consisting of a metal termed "aluminium" and of oxygen. It exists extensively diffused through nature, and is the essential constituent of all clays, or, at all events, is *an* essential constituent of all clays. It exists in nature beautifully crystallized, and is then known as corundum. When coloured blue it is termed sapphire, when red, ruby. Sometimes this corundum occurs opaque from the presence of impurities, and then we have it in the form of common emery. In the laboratory of the chemist, dried alumina is known simply as a white amorphous powder, excessively insoluble and infusible. Having described the physical and chemical properties of alumina, we proceeded then to examine certain methods by which it can be obtained in a crystalline form. We will now pass on to consider further this part of our subject.

In the first place, the lecturer claimed attention to a singular and beautiful mineral "staurolite," which has been prepared artificially. A word by way of caution. It does not follow that the methods by which we can prepare mineral matters crystallized in the laboratory, should be precisely those which nature herself has adopted on a great scale, though in many cases there is no doubt that the processes employed are really identical with those which nature herself has employed. Then, again, there is another very important point to bear in mind. The same mineral substance may be produced by methods entirely distinct. The well-known and beautiful mineral termed "felspar" can be produced both by the agency of liquids at a tolerably high temperature, and also directly by igneous fusion. Specimens of magnificently crystallized felspar have been taken from furnaces, where there is no doubt about the mode of its production. And now for this mineral, staurolite, which is a silicate of alumina. We are indebted to Deville for a singular experiment regarding the formation of this mineral. It does not at all follow that his process should be exactly that which nature herself has adopted, but still it is remarkably illustrative of what may occur, and on that account is worthy of notice in detail. We take a porcelain tube, and place it vertically in a furnace. It is open at both ends, and we introduce through the upper part of the tube the gas, fluoride of silicon. At the top we have a layer of alumina; then there is a layer of silica; and so on in alternation—alumina, silica, alumina, silica—beginning with alumina, and finishing with silica. We will heat that tube to red-whiteness, and then note the result. The gas, fluoride of silicon, is a compound of fluorine and silicon. When it comes in contact with the alumina, a curious reaction takes place. A portion of the silica is deposited here, and we get the mineral silicate of alumina, a corresponding proportion of the aluminium displaced and volatilized in the form of fluoride of aluminium. It is important clearly to understand this part of the operation. You perceive that we bring fluoride of silicon in contact with alumina, that is, with a compound of aluminium and oxygen. A reaction takes place between those two substances at this temperature, whereby silicate of alumina is produced. The mineral, staurolite, happens to be this particular silicate of alumina, and fluoride of aluminium is evolved. That descending, and coming in contact with the stratum of silica beneath, undergoes a change similar to that which the fluoride of silicon underwent in the first instance, and we get the same mineral formed in the second layer from silica as was formed in the first layer from alumina—in one instance by the action of fluoride of silicon, and in the other by the action of fluoride of aluminium. At the second decomposition there is fluoride of silicon evolved, which acts upon the aluminium below exactly as in the first instance; and so it goes on in succession, and at length you obtain the tube full of the mineral staurolite—this silicate of alumina, and yet you have only employed a small amount of fluoride of silicon in the first instance to effect this transformation. Thus, by a small amount of this body, you can convert an indefinite quantity of alumina and silica into this mineral. As much fluoride of silicon finally escapes from the tube as entered it in the first instance. It is one of the most beautiful and striking experiments in the whole of this department of science. The staurolite produced in this way is crystallized.

We pass on to a few remarks on another curious and important mineral,—namely, topaz. This is a compound, the precise rational composition of which does not appear to be very clearly understood even at the present time. It is essentially a silicate of alumina containing fluorine, but some doubt is entertained as to the exact mode in which that fluorine exists in the compound.

Now, one might have reasonably anticipated that topaz might have been produced in some such way as that just explained with regard to the production of staurolite; but, according to Deville, who tried the experiment, topaz cannot be so formed. There is, however, some little discrepancy in the statements which have been made on this point; for Daubrée states that it is formed by heating alumina to redness in a current of fluoride of silicon. We must wait for further information, seeing that these two chemists disagree on the subject. But if topaz cannot be so formed, a peculiar mineral termed "zircon," which is a silicate of zirconia (zirconia corresponding in formula with alumina), may be produced in beautiful crystals when the fluoride of silicon is passed over zirconia. Take a tube containing zirconia, and heat it to a good red-heat, or more than that, and then pass over the gas fluoride of silicon, and you obtain the mineral crystallized

—a silicate of zirconia. It occurs, Deville says, in octahedral crystals, and these crystals exactly resemble those of Monte Somma, in Vesuvius. He assures us that they have the same faces, the same angles, and the same external characteristics; so that he concludes that it is almost certain that they must have resulted from the same process—from the same operation of fire. Every mineralogist knows that certain specific minerals have peculiarities according to the locality, and these must depend upon certain conditions attending their formation. Now, as these crystals of zircon possess such an assemblage of characteristics, we may reasonably admit that Deville's conclusion has something like a good foundation to rest upon. Then he further remarks, it may be demonstrated that the small quantities of fluor existing in the metamorphic rocks, or rather beds of this kind, have sufficed to form indefinite quantities of zircon. We shall, by-and-by, direct attention to the subject of fluor, which may have played a very important part in the economy of nature,—a much more important part than many persons are yet disposed to admit. It is, as we shall see, a very widely-diffused element, though occurring only in small quantity.

When the same experiment was made entirely with zirconia instead of alumina, the whole contents of the tube were completely transformed into zircon. Zircon occurs in rocks which, there is reason to believe, have been exposed to a tolerably high temperature. It occurs in the syenite of Norway, for example, replacing felspar; so that the rock consists only of hornblende, zircon, and a small quantity of quartz; hence the rock is designated "zircon-syenite."

The next mineral which it may be interesting to examine is the mineral termed "cryolite," which, in fact, forms a geological bed. It is an exceedingly remarkable mineral, fusible at a comparatively low temperature. It is a compound of fluoride of sodium and fluoride of aluminium. Its formula is $3NaFl + Al_2Fl_3$. It is an anhydrous mineral—that is, free from water. It contains about 13 per cent. of aluminium. It is found in Greenland in a layer of gneiss, and in the vicinity of mica. According to Bischoff, there is a quantity of mica about it, which he supposes has played a very important part. The bed of cryolite is eighteen feet thick. Cryolite is associated with various minerals which undoubtedly are of aqueous origin. For example, iron pyrites—though certainly not prepared at a high temperature—copper pyrites, galena, and sparry iron ore, which certainly never could have occurred at a high temperature,—these are the associates of cryolite, and they tell us the story of its formation. It is clearly produced by the agency of water as a solvent. It may be produced by melting together directly fluoride of aluminium and fluoride of sodium. It may also be formed in the wet way by digesting fluoride of sodium with excess of hydrochloric acid and common gelatinous alumina.

Bischoff supposes mica to have played a very important part as a source of fluorine,—indeed, as a source of fluorine in common fluor spar which we meet with in so many localities.

The next subject for our consideration is one of considerable importance —of the highest importance; it is that of calcium and lime.

All lime, like alumina, contains a metallic base. Calcium, the base of lime, is exceedingly light, has a yellowish colour, is readily fusible, and exceedingly oxidizable, so that it is impossible to expose it to the air without its undergoing oxidation—contrary to what we have seen is the case with aluminium. Recently, some important experiments have been made by Wöhler on the subject. He has discovered certain combinations of carbon and calcium equivalent to those known in iron—in the form of pig iron.

It is with lime especially, and its compounds, that we have to do. Lime is composed of one equivalent of calcium and one of oxygen. You are all familiar with the properties of lime—an amorphous body, white, or more or less coloured with impurity, and which, on the application of water, slacks; that is, it absorbs water, the water enters into combination with it, and becomes solid, and on its passing from the liquid to the solid state, a large amount of heat is evolved. The lime falls to pieces, having become hydrated, or, in common language, slacked. It is slightly soluble in water, as every one knows, producing the well-known liquid called lime-water. When combined with water—for it must be hydrated—it unites readily with carbonic acid, forming carbonate of lime.

Carbonate of lime is a mineral which occurs very extensively in nature, forming beds of chalk, limestone, and two very important minerals, namely, calcite and arragonite. Carbonate of lime is a compound of one equivalent of carbonic acid and one of lime. It is known in three distinct states. There is, first, the amorphous or chalk-like state: we will call it chalk. It is perfectly non-crystalline or amorphous. There is, then, the form of arragonite which occurs in prismatic crystals, and belongs to the prismatic system. The third form of carbonate of lime is that of calcite or calcspar, which is rhombohedral, crystallizing in the beautiful rhombohedral crystals with which every mineralogist is familiar. Arragonite varies in specific gravity from 2·93 to 3·01. This is a point to note. The calcite has a lower specific gravity, ranging from 2·69 to 2·75, so that not only in their crystalline system, but also in specific gravity, are these two minerals distinguished clearly from each other.

The next point is the solubility of carbonate of lime. In treating this subject of chemical geology, the lecturer was selecting all those points which he conceived had a direct geological bearing; and it is requisite to pay rather close attention, which, perhaps, may be considered tedious, to this part of our subject. One part of carbonate of lime dissolves in 110,000 parts of pure water, in round numbers: it is 110,132 parts really. This carbonate of lime dissolves to a much greater extent when carbonic acid is passed through the water, and it then forms what is termed bicarbonate of lime. One part of carbonate of lime dissolves in 998 parts of water containing carbonic acid, according to Bischoff, the carbonic acid being passed through the water for an hour. He has made several experiments upon this subject, which are remarkable. He finds that the solubility varies to a great extent with the nature of the carbonate of lime operated upon. Thus, 11·15 parts of chalk were dissolved in 10,000 parts of water by passing carbonic acid through for an hour. He performed this experiment three times, and each time he obtained pretty nearly the same result; but, when he tried the experiment with carbonate of lime precipitated from a salt of lime, passing the carbonic acid through for about the same time as he did in the experiments with the chalk, he found that 28 parts dissolved in 10,000 parts of water. There is another very striking statement, but which will require further corroboration. It is, that burnt muschelkalk dissolved to the extent of 135·3 parts in 10,000 parts of water, by passing carbonic acid through the water for an hour and a half.

In passing, he would mention the fact, that when arragonite is exposed to a red-heat, it falls to powder; and it was supposed for a long time that this powder consisted of minute rhombs of calcite. This, however, is denied by Gustave Rose, who contends that the powder is strictly amorphous.

Let us now consider the mode of formation of arragonite, or the conditions under which it may be produced; and, when we understand these conditions, we shall find that the information afforded will tend to elucidate the formation of certain geological phenomena, especially with reference to temperature. It will indicate to us the temperature and other conditions under which rocks containing arragonite may have been formed.

Arragonite may be formed by dropping common chloride of calcium in molten carbonate of potash or soda. The method is to melt the carbonate, and then drop in the chloride of calcium. Decomposition occurs, and chloride of potassium or sodium and carbonate of lime are formed. We owe to Gustave Rose several experiments upon this subject, which, though they may seem somewhat minute and tedious, are extremely important and interesting. In the molten state the mass is clear, but it becomes opaque and white on solidification. Upon washing the product with cold water, an amorphous carbonate of lime or chalk was produced. It was always obtained at first in minute microscopic globules, perfectly amorphous, or non-crystalline; but Rose tells us that after twenty-four hours the whole became changed into rhombic crystals of calcspar. That is a curious point, and the lecturer asked particular attention to the temperature of the water employed, and the degree of dilution, for all depended upon those two conditions. On the other hand, by boiling the product in water, instead of washing it with cold water, the globules are almost instantly changed, not into rhombs of calcspar, but into prisms of arragonite. This little difference of temperature, then, is sufficient to effect this great change. These microscopic crystals of arragonite being left to cool in the water, become transformed into rhombs of calcite. He found that the same results were obtained by substituting chalk, arragonite powder, or calcspar, for chloride of calcium. Some experiments on this subject were made a long time ago by Becquerel, to whom we are deeply indebted for a great variety of experiments bearing on the subject of mineralogy. He was one of the first to take up the subject energetically. He formed arragonite by leaving plates of selenite or gypsum during several years in contact with a solution of bicarbonate of soda of the specific gravity of 1·070. The result of the decomposition was sulphate of soda and carbonate of line. The carbonate of lime produced appeared in the form of crystallized arragonite. The crystals consisted of very acute double pyramids, base to base, thus producing a very acute dodecahedron. The same result was obtained in a few days by heating to the boiling-point (100° C.) plates of selenite in a solution of bicarbonate of soda, saturated cold. The solution was contained in hermetically-sealed tubes of glass, and great pressure was given by a very ingenious artifice. There was no necessity in this case for raising the temperature of the glass very high to get the pressure. The pressure required was about five atmospheres, and this was obtained by half filling the glass with the solution in question, and then putting in a few drops of bisulphide of carbon, which is an exceedingly volatile body. It was inert, having no effect whatever upon the solution, but it enabled him to get a pressure of five atmospheres at this low temperature. He tells us that the crystals of arragonite which he thus formed were very distinct and very limpid, and in ten days they were $\frac{4}{100}$ths of an inch on the side.

These various points are apparently trivial, but in their application they may be of considerable importance, as what appear to be small things very often are. Gustave Rose found that, by leaving a very dilute aqueous solution of carbonate of lime in excess of carbonic acid, freely exposed to the air, arragonite was formed. All depends upon the solution being very dilute and at the ordinary temperature. If a common solution of carbonate of lime in excess of carbonic acid is thus left exposed, you will get, not arragonite, but crystals of calcite. This is a remarkable fact. By heating a common solution of carbonate of lime—that is, a solution containing the ordinary amount of carbonate of lime dissolved by virtue of the presence of carbonic acid—you get arragonite, and not calcite. An ordinary solution of carbonate of lime, or—what is equivalent—a much stronger one, gives calcite by exposure at the ordinary temperature; and this same solution, when heated, deposits arragonite. If such a solution be evaporated in a platinum vessel, the residue contains carbonate of lime in all three forms, namely, the amorphous or chalk, arragonite, and calcspar. This is an important point.

Having obtained these results, Rose then went on to investigate the precise changes corresponding to different degrees of temperature. These are his chief results :—At 100 Centigrade—that is, the boiling-point of water—the greatest part of the residue was arragonite in characteristic small prisms. At 90° the most arragonite was formed, and the crystals were larger than at other temperatures. At 70° the rhombic crystals of calcspar predominated, and were accompanied by hexagonal plates and small stars of calcspar, and the arragonite crystals were small. At 50° there was more calcspar, and the proportion of plates and stars, as compared with the rhombs of calcspar, increased. The arragonite crystals were thicker, and often bent or curved. At 30° no arragonite whatever was formed. The rhombic crystals of calcspar were comparatively large, and there were still some plates and stars. It is very remarkable that he should get these varieties of deposit under these different degrees of temperature and solution. All the arragonite occurred at a higher temperature than 30°, and the hexagonal plates of calcspar were formed at a lower temperature than 70°. Calcspar is always formed in solutions containing carbonate of lime, when carbonic acid is set free. By exposing in a warm place a well-stoppered vessel containing a concentrated solution of carbonate of lime in excess of carbonic acid, crystals of calcspar were deposited.

Experiments were also made by Rose, with especial regard to the influence of the degree of dilution, and so forth, upon the result. He took two ordinary small flasks—one containing a very dilute solution of carbonate of soda, and the other containing a dilute solution of chloride of calcium; he tied them together, and then immersed them in a cylindrical vessel of water. He left them under the water, and, in consequence of diffusion, a mixture took place with extreme slowness, the chloride of calcium mixing with the carbonate of soda. In this case, the result was the formation of arragonite; and if the solutions were a little stronger, he then got calcspar. The conclusion, therefore is, that, under special conditions of dilution, arragonite may be formed even at the ordinary temperature.

In native arragonite a little carbonate of strontia is found frequently, but not always. Its maximum amount, taking a goodly number of analyses recorded, is stated at 2½ per cent. It ranges from a trace to 2½ per cent. At one time it was supposed that the carbonate of strontia was a universal and essential constituent of all arragonite, and that this determined its crystalline form. That opinion, however, has been shown to be an error, because we not unfrequently find arragonite free from strontia. A little water is also generally present in arragonite. The extremes given by a number of analyses are 0·17 per cent. and 0·41 per cent. Water is given as a constituent in all of them. Arragonite is deposited from hot springs, as at Carlsbad, where there is a well-known spring. It occurs also in gypsum at Molina, in Arragon, and at Dax, in the Landes. It is also found in basaltic rock in the serpentine rock in the Valley of St. Nicholas, in Piedmont, in lavas in Vesuvius and Iceland, in beds of brown iron ore at Saalfeld, the Harz, and Styria.

We now come to the mineral calcite, calcspar, or Iceland spar. This calcite is pure carbonate of lime. So far as analyses tell us, some specimens of Iceland spar are absolutely chemically pure. Sometimes they contain about one-half per cent. of water, and they not unfrequently enclose foreign matters, such as copper pyrites and sand.

Next, as to the formation of calcite. Calcspar, or crystallized carbonate of lime, crystallizes in the rhombic system. We have seen that it can be produced by means of water; we will now consider its production through the agency of fire only. We have all heard of the famous experiments of Sir James Hall; they were commenced in 1798, and the results were communicated to the Royal Society of Edinburgh. He informs us that he took amorphous carbonate of lime, or chalk, and by exposing it to a high temperature under considerable pressure, he succeeded in converting it into saccharoidal limestone, like Carrara marble. The lecturer had had an opportunity of seeing one specimen prepared by Sir James Hall, and he must say that the result did not strike him as conclusive. But now for the evidence. He enclosed carbonate of lime in gun-barrels, and resorted to various expedients of plugging those gun-barrels, such as plugs of soft metal, and so forth. He then exposed a portion of the gun-barrel to a high temperature, taking care to arrange the tube horizontally in such a manner that the plug of soft metal should not be melted; and he obtained a hard substance like limestone after having exposed chalk to these conditions. He says, "My first application of this scheme was carried on with a common gun-barrel cut off at the touch-hole, and welded very strongly at the breech by means of a plug of iron. Into it I introduced the carbonate, previously rammed into a cartridge of paper or pasteboard, in order to protect it from the iron, by which, in some former trials the subject of experiment had been contaminated throughout during the action of heat. I then rammed the rest of the barrel full of pounded clay, previously baked in a strong heat; and I had the muzzle closed like the breech, by a plug of iron welded upon it in a common forge, the rest of the barrel being kept cold during this operation by means of wet cloths." This gives you an idea of one of his experiments. Then he comes to the use of fusible metal. He employed tubes of glass. It is desirable particularly to examine the evidence upon this subject, because it is one on which much stress has been laid. The lecturer did not wish to question unnecessarily the accuracy of Sir James Hall's conclusions, but he might remark that the carbonate of lime being heated to a high temperature in contact with glass, the result would be altogether vitiated, and the crystallization could not be said to depend merely upon the outward conditions to which the substance was exposed. We find that in other experiments he used small quantities of carbonate of lime in contact with silica and clay; but the presence of these two bodies would very much modify the result. In other experiments he used borax, and that again would altogether vitiate the result. Therefore, the conclusions drawn from these experiments are unworthy of being received—at all events, without further evidence. He tells us that in several cases the material which he obtained, although resembling crystalline limestone, fell to pieces on exposure to the air. That, however, is not the property of crystalline limestone. No doubt the investigations of Sir James Hall were conducted with perfect honesty and candour, and they must have involved a great deal of expense; but, as far as we know, recourse was never had to chemical analysis, and without that no result ought to be received. Indeed, Sir James Hall himself confesses his deficiency in chemical knowledge. He tells us that in various experiments he got a product in glass-like drops which were semi-transparent, and this clearly proves that the carbonate of lime operated upon could not have been pure. Having carefully gone over these experiments, the lecturer had no hesitation in stating that he considered them to be unsatisfactory. "By the lens," he says, "this same surface was seen to be glazed all over, though irregularly, showing here and there some air-holes. In fracture it was semi-transparent, more vitreous than crystalline." Last of all, he uses platinum, to obviate the effect of the iron. The effect of the iron would be to act as a strongly reducing agent upon the carbonic acid by the formation of carbonic oxide, and the tendency to decompose the carbonate, would, of course, be facilitated by reasons which are well known to chemists.

It appears after all that Sir James Hall obtained some results which would certainly lead us to believe that, by the application of a strong red-heat, carbonate of lime would acquire a crystalline structure; but it is exceedingly desirable that these experiments should be repeated with all possible care, that the question may be cleared up satisfactorily. No doubt they would involve considerable expense; but if proper care were taken, and proper apparatus employed, there is no doubt that we should obtain something like very decisive results. The Hall experiments extended over several years; but, looking at the results, he could not feel that confidence which seems to be generally reposed in them. Some years ago, Gustave Rose took up the subject, and came to the conclusion that Sir James Hall had been entirely mistaken; but more recently he has come to an opposite conclusion. But Rose's experiments are by no means so conclusive as they might be. In his recent experiments, which are published only this year, and will be found in the 118th volume of Poggendorf's Annalen, by employing a wrought-iron vessel, electro-plated with nickel, and capable of being closed,—so avoiding the contact of iron at a high temperature with the carbonate of lime operated upon, and, consequently, the reducing action of that metal on the carbonic acid of the carbonate of line,—he succeeded in changing arragonite into a substance having the characteristic appearance of Carrara marble. The experiment, he tells us, was conducted in a Siemen's gas-furnace—that is, a furnace capable of sustaining a long-continued and high temperature. A closed, unglazed porcelain vessel was employed, and exposed to a white heat during half an hour; and he informs us that under these conditions a piece of lithographic stone became greyish-white in fracture, and, under a lens, was found to be finely granular. The product was analysed, and contained—lime, 56·61; magnesia, 0·41; carbonic acid, 42·37; residue, 0·45. Pure carbonate of lime contains 56 per cent. of lime and 44 per cent. of carbonic acid: what was the undetermined residue? The presence of a small amount of silica might make a considerable alteration in the result. After carefully examining the way in which Rose's experiment was conducted, it appears to me inconclusive. It is obvious that there could have been no sensible degree of pressure. The porcelain vessel was not in the least injured, so that the temperature must have been much below that which we can now command—as, for instance, in the fusion of platinum. It is most desirable that we should have some further investigation on the subject. The British Association might take up the question with advantage; they have funds at their command, and it would be exceedingly desirable to settle this important point once for all.

What we call carbonate of lime in nature—take even the purest marble—is not pure. At one time the lecturer was anxious to investigate this point, and he went to a sculptor and obtained numerous varieties of marble, but in not one of them did he fail to detect alumina. Chalk is an impure body, and the presence of foreign matter might altogether modify the results of experiments made with it. There is, for example, a well-known variety of fire-brick, which consists almost entirely of silica. Upon taking hold of it, you will find that it is a hard, solid, enduring brick. You may ask, "How could you get this silica to unite so as to form a hard brick?" For a long time it was kept secret: it was done by the intermingling of a very small proportion of lime, which caused the formation of one solid brick; and it is very possible that foreign matters might be present, and modify the result of experiments made on the crystallization of carbonate of lime. We ought to appeal to chemical analysis to inform us what we are doing. It is vain to rely upon experiments where chemical analysis is not brought into use, or we may be led into serious error.

The next question we shall have to consider is, the derivation of lime in nature. What ready source of carbonate of lime is there in nature? According to Bischoff, in his valuable and compendious book on chemical geology, it exists in the so-called Plutonic rocks in combination with silica, forming silicate of lime; and this compound is decomposed by water containing carbonic acid, even when in mechanical suspension in the water.

Dublin Royal Society.—*January* 18.—Mr. E. J. Reynolds read a paper "On Spectrum Analysis." In the latter part of his discourse, the application of the method of spectrum-analysis to the examination of minerals was treated of. In examining refractory minerals in order to obtain the characteristic spectra of the metals contained in them, the author employs a peculiar form of gas-jet, which is essentially a Herapath's blowpipe-jet urged by a current of steam rendered acid by hydrochloric acid. The steam-jet should never be so powerful as to blow the test specimen off the platinum wires. By this means the decomposition of many minerals is effected without having recourse to the previous action of ordinary chemical agents upon them, as has been hitherto necessary in preparing them for examination in the spectrum apparatus. The discussion of the real aid to be derived from the application of the spectrum analytical method to mineral analysis was then entered upon, and Mr. Reynolds expressed his belief, on experimental grounds, that the various spectra materially interfered with each other, notwithstanding the statements of MM. Bunsen and Kirchhoff and others to the contrary; and he showed that the presence of a considerable proportion of sodium and barium compounds, in a mixture of salts of different acids and bases, serves to completely mask or intercept the spectra of lithium, potassium, strontium, and calcium when present in comparatively small quantities. After discussing this portion of the subject at some length, the author expressed his belief that the method of spectrum-analysis, as it now stands, beautiful and delicate though its indications are, must be looked upon rather as a useful aid to the ordinary analytical process than as a method of analysis perfect in itself under all conditions. Mr. Reynolds concluded by observing that he has hitherto been unable to find any traces of rubidium or cæsium in any Irish minerals; but thallium was found in three specimens of copper-pyrites from different portions of the Knockmahon mines, Bonmahon, co. Waterford, and in one specimen of the same mineral from Ballydehobb mine, co. Cork. The amount of the metal present in every case was extremely minute.

ROYAL INSTITUTION.—*February* 26.—The Friday evening lecture was "On the Quaternary Flint Implements of Abbeville, Amiens, Hoxne, etc., their Geological Position and History." By Joseph Prestwich, F.R.S. —Mr. Prestwich remarked upon the imputation of rashness, and even of credulity, which discoveries such as that of the flint implements often entailed upon geologists. He contended that geologists were, on the contrary, generally disposed to be incredulous. At one time they believed that fishes were no older than the Carboniferous strata; that reptiles first appeared during the Liassic period; and that mammalia could not be traced beyond the Tertiary strata; and it was a long time before they were satisfied that fishes go back to the Silurian, reptiles to the Carboniferous,* and mammalia to the Triassic period. And so with man. Ten years ago there was scarcely a geologist in this country who would not have deemed the occurrence of the works of man in any beds older than the recent alluvium impossible. The discoveries made by Tournal and Christol in the south of France, thirty years since, of the remains of man associated with those of extinct mammalia, were rejected by geologists unanimously; nor were the analogous discoveries of Schmerling in Belgium more favourably received; whilst Frere's remarkable notice, so far back as 1797, of the discovery, at Hoxne, in Suffolk, of flint weapons mixed up with the bones of large extinct animals, was allowed to lie dormant for sixty years.

Even so late as 1855, a communication by the Torquay Natural History Society, respecting the occurrence of worked flints with the fossil bones in Kent's Cave,—a fact already, years before, noticed by the Rev. Mr. M'Enery and by Mr. Godwin-Austen,—was deemed, by the Geological Society, too improbable for publication.

Mr. Prestwich doubted whether, prior to 1858 and 1859, there were twenty men of science in Europe who would have admitted the possibility of the contemporaneity of man and of the extinct mammalia. He instanced Dr. Grant as one of the small number who, on abstract principles, treated the question as an open one. He also noticed the tone of confident disbelief with which the asserted occurrence of flint implements in certain geological deposits in the Somme valley was spoken of when he made inquiries respecting this subject in Paris in 1856 and 1857, and which for a time turned him from the inquiry. Such instances might be multiplied. The speaker did not bring them forward as indicating any perverse opposition, but to show how reluctant geologists were to abandon the belief generally held on this subject without the clearest proofs, and close and careful search on their part. Such, he remarked, is the inevitable progress of all discovery. Facts deemed contradictory to received theory are often long rejected, some as clearly failing in proof, others as non-proven. Evidence is hesitatingly received, and has to force its way through a resisting stratum of incredulity; but, as in the searching resistance offered by close tissues in the separation of mercury from its dross, that portion which passes through issues the brighter and purer the more difficult the transit, and the stronger the pressure exercised.

Allusion was then made to the distinguished palæontologist, Dr. Falconer—one man of science at least in this country with whom the conviction that the remains of man might be traced back to periods greatly antecedent to our ordinary records, had grown, during a long course of years, from probabilities suggested by Eastern research, into certainty established by extensive investigation among the European fossil-bone caves. Referring to his late exploration of Brixham Cave in 1858, the attention which the well-certified discovery of flint implements in undoubted association with the remains of extinct mammalia and of reindeer attracted amongst geologists was remarked upon. The speaker visited the cave in company with Mr. Pengelly, and was much struck with the force of the evidence, though, for various reasons, he considered that cave evidence alone was not sufficient. Urged by Dr. Falconer to go and examine the geological evidence respecting the flint implements in the valley of the Somme, he afterwards paid his long-intended visit to Abbeville (where he, on the very first day, was fortunate enough to find three worked flints at Menchecourt.) He was joined, on the next day, at Amiens, by his friend Mr. John Evans. The geological evidence, and the character of the flint implements, satisfied them both that here again was an undoubted case of contemporaneity of the works of man with the remains of the extinct mammalia. All the author has since seen on many subsequent visits to the Somme valley, sometimes alone, but more frequently in company with other geologists, has tended to confirm his first opinion. He then proceeded to notice some of the phenomena he had seen, and to give his conclusions respecting them. He had intended to have described the several localities in France and England at which flint implements had been found, but found that time would not allow his going beyond Amiens. This was the less important, as Mr. Lubbock had so recently given an able account in the same room of most of these places; and his auditors were probably most of them acquainted with the more general account given by Sir Charles Lyell in his recent work on the 'Antiquity of Man.'

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* Possibly to the Old Red Sandstone.

Mr. Prestwich then went on to describe the remarkable discovery of M. Boucher de Perthes, and how much honour and credit were due to him for his untiring perseverance, in face of general discouragement, for a period of twenty years, and for twelve years after the publication of his elaborate work, 'Antiquités Celtiques et Antédiluviennes.' Incited by this work, Dr. Rigollot, an antiquary of Amiens, discovered flint implements in great numbers near that town; but his careful memoir on the subject, although it attracted the momentary attention of some French geologists, was allowed to drop comparatively unnoticed. Geologists admitted the antiquity of the beds, and antiquaries admitted the workmanship of the implements; but neither would own to a conjoint interest and belief in them.

Before entering upon the details of the sections, Mr. Prestwich proceeded to make a few remarks upon the conditions under which the flint-implement-bearing beds were found, and how their importance and the time they represent were to be judged of. He observed that sea-formed deposits afforded massive and tangible monuments of the length of time required for their accumulation. But on land time passes, and builds no such monuments of its duration. The sand and shingle beds of a rapid river would be little, if at all, thicker now than a thousand years ago, for, instead of accumulating in the channel of that river, they are incessantly removed, and carried eventually out to sea, where they contribute to the formation of the great sedimentary deposits constantly going on there. The time represented by river deposits (apart from the recent silty alluvia) is not therefore to be measured by their thickness; and we must not attach the less importance to the beds containing the flint implements, because, being formed by river action, they are necessarily small, fragmentary, and superficial. But while in the sea the accumulation of matter has formed a relative measure of time, on land the extent of denudation resulting from the removal of a portion of that matter supplies an obverse scale. In the former case the lapse of time is chronicled by constantly accruing deposits, whereas in the latter case the deposits cannot exceed a certain thickness. They are constant quantities, and their dimensions are no measure of their age. The only test of their age consists in their organic remains, and in the depth of the valleys below the terraces on which portions of them are lodged. In speaking of river action, the author does not refer to the slow and sluggish streams of this country, but to the more active streams of countries of greater rainfall, or to old conditions of former periods.

Mr. Prestwich then proceeded to refer to a large pictorial section of the celebrated pit at St. Acheul, near Amiens. The artist had not visited Amiens, but had skilfully contrived to give a sufficiently accurate representation of the town and valley, for the purpose of showing the general relation which the ground there bore to the surrounding district. The details of the pit were, however, all given from actual survey by the speaker. The surface of the ground at the pit is 100 feet above the level of the Somme, which flows in the valley at the foot of the hill. The valley itself is about one mile broad. The hills on either side, rising to a height of 200 to 300 feet, consist of chalk, with a few and distant cappings of Tertiary strata.

On platforms of various breadths, generally on the top of low hills adjoining the valley, patches of gravel occur at intervals more or less long from the lower to the upper end of the valley, whilst a more connected series of gravel beds skirts the base of the valley. The chief portion of the valley is, however, occupied by alluvial beds, beneath which the last-mentioned gravels, with their brick-earth, pass.

The higher level gravels rarely contain organic remains. The pit at St. Acheul affords a singularly good example of these beds, and is unusually rich in organic remains, and also in flint implements.

The section exhibits :—	Feet.
1. Brick-earth (Loess) without organic remains	10 to 15
2. A variable bed of whitish, marly sand, with numerous *freshwater* and *land shells* of recent species, and a few *mammalian remains*	3 to 7
3. Variable beds of subangular flint gravel—some white, others ochreous and ferruginous. Numerous *fossil bones* and *flint implements*, and a few *shells* as above, irregularly dispersed throughout	5 to 14

These beds repose upon a base of chalk. The site having been long occupied as a Gallo-Roman cemetery, the upper brick-earth is intersected with pits and graves,—in some there are stone, or rather hard chalk, coffins, whilst in others the nails and ironwork alone remain, the wood having entirely decayed away. These portions of disturbed ground are easily recognized by their darker colour, their contents, but more especially by the break they produce in the stratification of the beds. So long as the ground is undisturbed the lines of the brick-earth, the lamination of the sands, and the rough bedding of the gravel are continued in horizontal planes without break. Any interference from above breaks these lines and mixes the different beds, and renders the disturbance at once apparent. In the absence of any such indications it is to be assumed the fossils and the flint implements are in undisturbed ground.

The flint implements are found scattered irregularly through the gravel, but they are more numerous in the lower part. It has been estimated that there is one implement to one cubic yard of gravel. They occur singly, and, as far as we know, lying flat. The spot where one was found *in situ* by Mr. Flower was pointed out in the section, and also the spot where the speaker and Mr. Evans extracted one. These worked flints partake of all the mineral characters of the gravel—the result of contemporaneous deposition. Some retain their original dark colour, others are stained yellow and brown; some have their outer surface converted to a bright white; many are encrusted with thin patches of carbonate of lime; and many again exhibit dendritic markings,—all being conditions in perfect harmony with the mass of broken subangular flints composing the body of the gravel, of which they are, in fact, component parts, showing one and the other like characters of age. Several hundred specimens of flint implements from this pit have passed under the speaker's inspection; thirty selected specimens were exhibited, showing the principal forms which prevailed, and in which the workmanship and design were most apparent. Few can feel any doubt who inspect a series of this nature. It is not so much evidence of art and skill that we look for, but primarily of design. The speaker did not dwell on this point, which is now generally accepted. It has been well treated by Mr. Evans and others.

The fossils consist of perfect and uninjured, though very friable, land and fresh-water shells in the following proportion, and of bones, mostly broken, and teeth of the following animals. The list is necessarily only a sketch.

Fauna of the Quaternary Gravels of the Somme Valley.

	ANIMALS.	SHELLS.
Extinct species.	Elephas primigenius.	14 species of land shells.
	Elephas antiquus.	
	Rhinoceros tichorhinus.	9 species of marine shells (Abbeville only).
	Hippopotamus.	
	Ursus spelæus.	
	Hyæna spelæa.	21 species of freshwater shells.
	Felis.	
Some extinct, some living.	Cervus (2 or more species).	All these are of species living in France, and all but one in England, except the Cyrena fluminalis, now living in the Nile and Central Asia.
	Bos (2 or more species).	
	Equus (2 species).	

Proceeding to interrogate the section with a view to determine the causes which led to the formation of these beds, the nature of the climate which then prevailed and their age, the following conclusions were deduced:—

1. The mineral ingredients of the gravel are chiefly broken flints derived from the chalk of the district in general, but with these there occur fragments and blocks of Tertiary sandstone and Tertiary fossils, which could only have come from places ten to twenty miles higher up the valley. Therefore the agency, whatever it was, that brought the débris here must have proceeded in a direction down the present valley, the Tertiary débris being found along that line as far as the sea. Further, the cause could not have been a general one extending beyond the present hydrographical basin, for none of the older rock débris from the valley of the

Oise, which is only separated by a watershed six miles broad from that of the Somme, passes from it into the latter valley.

2. The presence of freshwater shells in some of the intercalated beds, many such as live in clear and rapid streams, indicates a probable fluviatile origin for these deposits.

3. The mammalian remains and land shells give evidence of dry land. The occasional occurrence of bones in the position they hold during life shows that the carcases and limbs of animals were dropped into the old shingle before they were freed from their integuments, or within a short time after death, whilst the perfect state of preservation of the land shells is an indication of their not having been transported far.

All these characters tend to prove that these beds are to be referred to old river action. This, however, must have taken place when the river occupied a level about 100 feet higher than it does now. It is true that similar gravels, containing similar mammalian remains and also flint implements, occur at lower levels (forty feet) in the valley, whence it is inferred that similar causes were in operation when these also were deposited. But it is plain that the two could not have been deposited at the same time. For the deposition of the high-level gravels on the supposition that the valley had been previously excavated, would have required a river at some times filling a channel more than a mile wide and 100 feet deep—a state of things not to be accounted for under any circumstances. The alternative therefore of a river flowing at the higher level and gradually excavating its channel is adopted.

The character of the climate may be inferred from the fauna. The land and freshwater shells are of species now living in France, but they also range as far north as Russia, Finland, and Siberia. They are therefore such as, though occurring in temperate climates, are capable of existing in high northern latitudes. The animal remains furnish more positive testimony. The woolly mammoth and rhinoceros were fitted by their coating to endure the rigours of a cold climate, such as Russia and Siberia, where their remains abound, and where they seem to have fed on vegetation common to such latitndes. A species of tiger now lives in Central Asia, and is often tracked and hunted down in the winter on the snow and frozen lakes of that region. The reindeer, of which we have the remains in the valley of the Somme, and the musk ox, which occurs in the same deposits in the valley of the Thames, indicate still more clearly the northern tendencies of this group. There is a difficulty about the hippopotamus, but the elephant and rhinoceros originally presented the same difficulty; and there seems no reason why in this case also the extinct species should not be found to have been fitted to live in a severe climate.

These conclusions are corroborated by the physical phenomena. Mr. Prestwich pointed on the large section to numerous blocks of sandstone but little worn, and varying in weight from half to five tons, which could hardly have been carried and deposited, as now found, by water alone. He also showed various contortions in the upper beds of gravel (whilst the lower ones were hardly disturbed), and in the laminated sands overlying them. These he attributed to ice-action. The blocks, to transport from places higher up the valley on ice-floes at the breaking up of the ice in the spring, and the contortions to the grounding of ice-floes on the soft sand and loose gravel, impinging into them and piling up the gravel, as now occurs on the banks of some of the Canadian rivers. He pointed especially to the pendent masses of brick-earth isolated in the upper part of the sands, and which he attributed to angular masses of ice brought down in flood time, grounding on the brick-earth and pushing a portion of it into the underlying beds of sand, where, as the ice gradually melted, it would be left, caught, and squeezed in by the sand pressing itself into place again.

The two classes of evidence are, therefore, conformable. It is in harmony also with the existence of the large beds of brick-earth or loess overlying the gravel, and which is, doubtless, the deposit of the old river during floods, usual in a severe climate at the time of the melting of the winter snows. The winter climate may probably have been as rigorous as that of Northern Russia or Northern Canada. Such a climate would not be any bar to the presence of man, whose works are found in these old shingle beds. It is true that none of his remains have yet been found in these deposits, but they are found in caves of the same age. The abundance of animal remains is the almost inevitable consequence of a country subject to great river-floods, by which large numbers of animals are always destroyed and swept down; man, on the contrary, guards against such risks. Along the Northern American rivers of the present day, although the remains of the buffalo and other animals occur in profusion, the remains of man are scarcely ever met with. There is every reason to expect that this further and desirable proof may be forthcoming at no long distance of time.

Lastly, the speaker stated that the present river Somme only carries down fine silt and mud, whereas the old river transported large masses of coarse shingle; therefore, it is to be inferred that the old river was one of much greater power than the present one. During floods especially its power must have been very great; with greater transporting power the river would possess greater excavating power; at the same time the disintegration of rocks, especially such soft rocks as the chalk of this district, produced by severe cold, combined with the effects of ground ice lifting up from the bed of the river large quantities of the shingle, would hasten the deepening of the valley. As it deepened, terraces of shingle have been left at places on the slopes. It may be difficult to imagine a river with so limited a collecting ground filling a valley a mile wide, but this the speaker supposes to have been the case only during floods, and that the ordinary channel of the river was very much smaller. He instanced a case in India where Dr. Hooker mentions a river which was only eighty yards wide when he crossed it, but which, after the rains, covered a channel three miles wide, and ran ten to twelve feet deep. The melting of the snow in the spring produces the same result in arctic regions as heavy and continued rains in southern regions.

Mr. Prestwich next exhibited a diagram to show what he conceived to be the different phases of the phenomena, from the period when the beds of St. Acheul were formed, until the valley assumed its present form and dimensions. The plan, which was formed of a series of superimposed sections, showed—

1. *The old river during the deposition of the shingle and sand banks of St. Acheul.*—In this the bed of the river was occupied with large shingle banks, which were left dry during the time the river was low. Mr. Prestwich supposes these to have been resorted to by early man, in consequence of the number of large flints they contained, for making flint implements on the spot. This may be one of the reasons why they are so numerous at St. Acheul, which was shown to be one of those old shingle banks preserved from that time. Ice-floes dropped large blocks of sandstone into the shingle. A space shut off in part by a shingle bank would account for

the more tranquil accumulation of the middle sand-beds of St. Acheul, and for the more numerous shells living there undisturbed. During flood, the river rose probably to a height of twenty to thirty feet above its ordinary level, as shown by the brick-earth (without gravel) deposited higher up the hill on the road to Cagny. The next stage showed—

2. *The gravel beds of St. Acheul after they were left dry, except during floods.*—Here the valley had been excavated to several feet below the level of the St. Acheul beds, but during floods the river still extended over them and deposited the brick-earth. Ice-floes grounded and indented the upper beds of sand and gravel, causing contortion of the strata.

3. *The river at the time of the formation of the low-level gravel beds of St. Roch and Amiens.*—The valley had now deepened to the extent of fifty to sixty feet below the level of St. Acheul, and the low-level gravels of St. Roch were deposited under similar conditions, only that ice-action is not so strongly marked. It is in these beds that the remains of the *hippopotamus* first appear. The flint implements found in them are of a somewhat different type to those of the higher level gravels. The flake form is more prevalent.

4. *The low-level gravel of St. Roch, left dry except during floods.*—Here we have a repetition of the same state of things as found at St. Acheul; the shingle being covered up during floods by brick-earth or loess.

5. *The valley at the present period.*—The progress of excavation shows the valley deepened to its full extent. The river has lost its old power, its flood waters now rising only two to three feet, and its channel being restricted within a very narrow compass. The old and rough channel left at the end of the Quaternary period is covered to the depth of ten to twenty feet by fine alluvial soil and peat. All the great pachyderms have become extinct, but the reindeer, bison, and great fossil ox survived during part of the more modern time. Almost all the small and fragile land and freshwater shells have continued in uninterruped descent to the present day. This fact seems almost conclusive against any general cataclysm having passed over the surface. This concordance between the physical features and the contemporary life, and the capability the hypothesis here offered gives of explaining each and every one of the phenomena, affords strong presumptive proof of its truth.

Before concluding, Mr. Prestwich observed that he might be expected to say a few words respecting the age of the flint implements. Two questions were involved in this,—one the length of time elapsed since the close of the period of the extinct mammalia; the other, how far back into that period the flint implements can be traced. In the description of the sections, it had been previously pointed out, that the Quaternary period could probably be brought down immediately to the time when our valleys began their modern accumulation of silt and peat. The period of time, therefore, first to be measured is that which has been required for the formation of these latter deposits. On this point there is considerable difference of opinion amongst geologists. The occasion did not afford time to enter into the details of the question, and the speaker therefore contented himself with an expression of opinion offered with reserve. He considered that more time and better data were required to make a sure estimate; nevertheless, he was satisfied that the evidence, as it exists, does not warrant the extreme length of time so frequently supposed. The recent alluvia covering the latest Quaternary deposits of our valleys are rarely more than forty feet thick, in most cases not more than twenty feet. The rate of accumulation, though it may often be slow, is very variable. A Roman road in the valley of the Lea was found covered by two feet only of alluvium. Another such road in Cambridgeshire was covered with five feet of alluvium. The entire depth of the alluvium was not, however, ascertained in either case. M. Rozet gives another instance of a Roman road, which he considers to have been kept in repair until about the eighth century, traversing the valley of the Dheune. Its paved and even surface is now covered by twelve inches and a half of alluvial soil. A little lower down the valley this alluvium, which is very uniform, has been ascertained to be about thirteen feet thick. This he estimates would have required for its accumulation about 10,000 years. The alluvial soil reposes there immediately on the so-called diluvium. The rapidity with which the alluvial soil will accumulate under favourable conditions is often very much greater. In places, thick beds of alluvium and of peat have been formed since the Roman occupation. Looking at these facts, and at the general fact, that as a rule, in the valleys of the Somme and of the Thames, for example, the Roman, British, or Gaulish remains are found at a depth from the surface bearing a considerable proportion to the entire thickness of the alluvium, the probability is, that the commencement of the alluvial deposits is not to be carried back indefinitely.

One reason for believing the accumulation of the silty alluvium of our valleys to have been more rapid at one time than now is, that these valleys, left rude and rugged at the end of the Quaternary period, would be subject to more frequent floods until their inequalities were filled up and levelled. Mr. Prestwich concluded by observing that for these and various other reasons he was confirmed in the opinion he expressed in 1859, that "the evidence, as it stood, seemed to me as much to necessitate the bringing forward of the extinct animals towards our own time as the carrying back of man in geological time." In making that observation, he had chiefly in view the distance of time at which the last of the great extinct mammalia disappeared. If there should have been, between the modern valley alluvia and the latest Quaternary beds, some intervening period of time of which we are ignorant, that distance may be materially prolonged. If, on the contrary, they followed in immediate succession,—and he thought we have evidence that such was the case, for there seems reason to believe that some of the large pachyderms still existed at the commencement of the alluvial period, whilst we know that many of the ruminants lived on uninterruptedly from one period to the other,—he did not, for his part, see any geological reasons why the great extinct mammalia should not have lived down to comparatively recent times, possibly not further back than 8000 to 10,000 years.

"But this only brings us to the threshold of that dim and mysterious antiquity in which first appear those rudely-wrought flints—those evident works of design—those palpable shadowings of man. Here our chronology fails us altogether. If we look at our broad and long valleys, and then at the comparatively small streams now winding through them, and suppose these streams to have been the same in past times as they now are, we could hardly avoid the conclusion that the time required to produce such excavations with such means must be almost incalculable. But if the view here proposed be correct, it would follow that with rivers so large in proportion to those now occupying the same valleys, with floods of a force now unknown in the same districts, with a cold so severe as to shatter the rocks and to hasten the removal of their débris, we should have, I contend, agencies in operation so far exceeding in power any now acting in these countries, that it is impossible to apply the same rules to the two periods. The changes described must have progressed with a rapidity of which we, at the present day, can in these latitudes hardly form an adequate conception.

"But, although I would shorten the Quaternary period by the extent of the differences here alluded to, it still remains of great length and importance, stretching back into a far remote antiquity, and it is far into this period that we have traced these works of man. Although at present we are without a scale or measure to determine that antiquity, we need not abandon the hope that, by continued and careful observation, we may eventually succeed in forming some comparative estimate of it. The first men who, after traversing the plains of Lombardy, approached the Alps, could scarcely have failed to realize their vast dimensions, although without the means to determine their exact height; so we, from the relative magnitude of the phenomena and the variation of life, can sufficiently well realize the remoteness of the time in question, although we do not possess the data whereby to measure its duration, and determine its exact distance from our own time."

Royal Geological Society of Ireland.—*April* 13.—The Rev. the Vice-Provost of Trinity College, President.

The President announced that as the change in the constitution of the society, which was announced on the notice-paper for the evening, might necessitate some slight change in the bye-laws, he would request that any gentleman who had candidates to propose for the honour of Fellowship of the society would mention their names, so that they might be balloted for at the next meeting.

The following names were then proposed:—A. Gahan, Esq., C.E.; H. Russell, Esq.; R. T. Brabazon, Esq.; R. Glascott Symes, Esq.; and Sandford Palmer, Esq. R. H. Ellis, Esq. was proposed as an Associate.

Mr. Scott read the following report from Council:—The idea has been frequently mooted within the last few years, that it would be advisable to have the name of the society altered, so as to make it the Geological Society of Ireland, as the title Geological Society of Dublin appears to confine its labours to the immediate vicinity of this city; whereas by the original resolution, passed in 1832, its objects were so defined as to embrace the whole of Ireland. In addition to this change, several influential members were of opinion that the addition of the word "Royal" to its title would be of great importance, as indicating that her Majesty was disposed to recognize its labours. The council accordingly, at their meeting on the 17th of February, appointed a sub-committee, consisting of the Rev. Professor Haughton, with the treasurers and secretaries, with full powers to act as they thought best. The sub-committee drew up a memorial, which was suitably engrossed, and they requested the following members to sign it:—The Earls of Enniskillen, Bandon, and Dunraven; Lords Talbot de Malahide and Dunally; Sir R. Griffith, Bart., with the President. They further requested Lord Talbot de Malahide, as a former President of the society, to have the kindness to forward the memorial to the Home Office, and they enclosed with it a complete copy of the Journal of the society for her Majesty's acceptance. The council have the honour to submit the reply which her Majesty has been graciously pleased to return to their memorial; and they cannot but, in the first instance, congratulate the society on this proof that their labours during the past year have been appreciated, as they would consider they deserve to be; and secondly, express a hope that the fact of the recognition of this body as the "Royal Geological Society of Ireland" may incite the Fellows to still further exertions in the cause of their favourite science. In conclusion, the council desire to tender their most sincere thanks to Lord Talbot de Malahide, to whose kindness they consider themselves mainly indebted for the successful issue to which their application has been brought. They would also express their warmest acknowledgments to Mr. Robert Mallet, F.R.S., who, though no longer resident in Dublin, is still unremitting in his interest in the society, of which he has been so long a distinguished member, and whose unceasing exertions in regard of this special accession of dignity to it have at last been crowned with success:—

"Whitehall, March 28, 1864.

"My Lord,—I have had the honour to lay before the Queen the petition, transmitted in your letter of the 17th instant, of certain members of the Geological Society of Dublin, on behalf of that Society, and I am to inform your Lordship that her Majesty has been graciously pleased to comply with the prayer of the petition, and to signify her desire that the Geological Society of Dublin be henceforth called 'The Royal Geological Society of Ireland,' and that the members thereof be styled 'Fellows of the Royal Geological Society of Ireland.' I am commanded by her Majesty to convey to the Society her thanks for the copy of the Journal of their proceedings, forwarded by your Lordship, which has been placed in the Royal Library at Windsor.—I have the honour to be, my Lord, your Lordship's obedient servant, (Signed) "G. GREY.

"The Lord Talbot de Malahide."

Mr. Ormsby read a paper on "A Polished and Striated Surface in the Limestone of Ross Hill, County Galway." On the Midland Railway, between Galway and Oranmore, there is a low range of hills, over which the line passes nearly at the surface of the ground. Some time since it was thought expedient to lower the road here to improve the gradients. When the surface clay was removed, a large portion of the top of the rock, for upwards of three hundred yards in length, was found to be brightly polished, grooved, and striated. Several borings were then made in the fields on each side, and different results obtained; but they all showed that the surface of the limestone beneath was smoothed and polished over a very considerable area. In various places in the rock were deep grooves, as if a plough had been driven over it, the cuts having in some cases sharp, jagged edges and a bold outline,—in others, soft, gentle slopes, like ripple marks on a sandstone. These deeper grooves and the principal striæ were in a direction nearly parallel to the railway, or magnetic east and west, while a series of minor striations run north-east and south-west. The former seem to be due to the violent rubbing of ice, most probably in the form of a glacier, and the latter may be ascribed to the subsequent action of the drift.

Mr. Jukes said that the society was indebted to Mr. Ormsby for the care with which he had investigated the subject, to which his own attention had been drawn by Mr. Ormsby in the course of last winter. He had lately visited the locality himself, and he could only say that the phenomenon was much more striking on a large scale than could be supposed from the inspection of a hand specimen. Surfaces fifty or sixty yards in length were laid bare, quite smooth, and dipping at a uniform angle of about half a degree. These smooth surfaces had been covered with clay, and their appearance was very different from that of surfaces which had been long exposed, showing how the erosive action of the air destroyed the markings of the direct action of ice. He (Mr. Jukes) did not know whether the polish was supposed to be produced by ice itself or by the clay beneath moving ice, an agency which would seem to him to have been necessary. At all events, from the gently undulating character of the country, it would seem that the ice did not belong to local glaciers, but more probably to a large sheet covering the whole surface of the district. In connection with this subject he would mention that his friend Dr. Melville, of Galway, had expressed the opinion that in the neighbourhood of that town they had the true "boulder clay" of Scotland, while in the east of Ireland the superficial deposit had been subjected to a considerable sifting action, which had changed its character. The general opinion at the present day is that this boulder clay is not aqueous drift, but consists of the débris of rocks ground down on dry land. Not far from Galway he had observed a sandy clay full of boulders, so compacted together as to form a sort of conglomerate, in parts almost stratified, which had been probably formed by the pushing action of the ice slipping from the land to the sea.

The Secretary read a paper by W. Harte, Esq., C.E., "On a New Echinoderm from the Yellow Sandstone of Donegal." The fossil which I have the honour to bring under the notice of the Royal Geological Society of Ireland, and of which I request their acceptance for their museum, was obtained by me lately in making a road on the western shore of Lough Eske, about six miles from Donegal. The specimen is a cast in the yellow sandstone, the markings being in an unusually good state of preservation. The shape is orbicular—depressed,—the base is wanting, and the cast seems to have yielded by pressure and is spread out, somewhat of a bell-mouthed shape, though this has been effected with very little distortion or disarrangement of the plates. The interambulacral spaces are composed at the lower extremity of the fossil of five rows of plates, and it is probable that they exceeded that number at the base. The two rows next the ambulacra are pentagonal except the upper plates, which are nearly triangular. The other three rows are hexagonal, very irregular, and nearly all become obsolete before reaching the ambulacra. These hexagonal plates are almost smooth, or at least only marked by very minute tubercles, of which, I think, traces can be detected. The genital and side pentagonal plates are very different. The genital plates have each a large perforate tubercle, as in Archæocidaris, surrounded by a depressed ring, and this is again surrounded by a ring of about sixteen pores. Of the rows next the ambulacra the first plate (counting downwards from the apex), which is nearly triangular, has a small tubercle. The rest of the plates in this row are all pentagonal, and both they and the tubercles increase in size downwards. The second, fourth, and seventh plates have each one large tubercle, surrounded by a depressed ring, and this again by a circle of very small tubercles. The third, fifth, and sixth plates are quite plain. The foregoing description applies to all the interambulacral spaces, so that thus we have a series of concentric circles in the pentagonal rows at increasing distances from the apex down. The ambulacra are large; the perforations are situated in two depressions, and consist of three rows of two each (six rows in all) in each ambulacral depression. Three small plates cover each space, and there are two perforations in each plate. Four of the ambulacral plates equal in depth one of the side plates. The dividing ridge shows the ambulacral plates well, having one small tubercle in each. A detached portion of either this same, or of another of these specimens, appears on the same stone close to it, showing the plates of the ambulacra very distinctly. There are no traces of any spines that I can see in this fossil, unlike the fossils of Archæocidaris to which I shall presently allude. This specimen appears to have been stripped of its spines before being buried in the sand. I have, however, found in the same bed, and near the same place, a few detached plates and the casts of what appear to be spines. I also find traces of large plates in some of the friable shales near it. The fossils associated with this specimen are not numerous. I have sent up a good specimen of *Psammodus porosus* from the same bed. In the limestone which underlies the sandstone there are a great abundance of fossils, of which by far the most characteristic are remains of Archæocidaris, which occur in the greatest profusion. They are found in groups of plates and spines; nearly all of these groups present more or less the same assemblage of hexagonal and pentagonal plates, the former tubercled, with numerous spines both smooth and muricated, giving the idea that each of these groups represents the remains of one or more of these animals as they fell to pieces. In no case do I find among these any pentagonal plates provided with tubercles like those of the cast in the sandstone; and accordingly differing, as it does, from both Palæchinus and Archæocidaris, I think that there can be no doubt that it is a new addition to the Echinoderms of the carboniferous period.—The paper was illustrated by a careful drawing of the specimen on an enlarged scale, for which the society was indebted to the kindness of Mr. Bailey, who, on being called on by the President, observed, that in his opinion the fossil belonged to the genus Archæocidaris, but was certainly a new species. He was led to this conclusion from the fact that the whole family of the Cidaridæ presented an appearance like that shown on the specimen, viz. that the plates exhibited one large tubercle. In the more recent specimens all the plates were tubercled, while in this Palæozoic fossil the tubercles only appeared on a few of them. He would only observe, in conclusion, that the society owed a great deal to Mr. Harte, by whose care and diligence this fossil had been discovered and laid before them, like many others which they had received from the same locality within the last few years.

Mr. Emerson Reynolds then read a short communication upon "Thalliferous Pyrites, from Ballydehob, county Cork." He said that he had examined several Irish ores for this element since he had laid his last notice on this subject before them in 1863, but that the present specimen was the only one in which he had succeeded in discovering thallium, and here only in small quantity.

Geological Society.—*April* 13.—1. "On the Geology and Mines of the Nevada Territory." By Mr. W. Phipps Blake.—In describing the physical features of the country, the author observed that it is an elevated semi-desert region, composed of a succession of longitudinal mountain-ranges with intermediate valleys and plains, the most abundant rocks being metamorphic and igneous; but Tertiary strata and Carboniferous Limestone also occur.

The author then described the hot springs, which are extended along a line of fissure in a granitic rock, and parallel to the mountains, and which deposit silica in an amorphous and a granular state, sulphur being also seen in the cracks and cavities of the siliceous deposit. He considered these phenomena to illustrate the formation of a quartz-vein in a fissure.

Mr. Blake then gave an account of certain mineral veins in porphyry, which yield sulphurets of silver (including crystals of Stephanite, but very little ruby silver) and a little gold; also galena, copper pyrites, iron pyrites, and a little native silver, the veinstone being a friable quartz. The prevailing direction of the veins was stated to be nearly north and south; and the author remarked that they were richer in gold near the surface than at greater depths.

2. "On the Red Rock in the Section at Hunstanton." By Mr. Harry Seeley, F.G.S., of the Woodwardian Museum, Cambridge.—The physical structure of the rock was first considered, and it was shown to be divisible into three beds, the uppermost of which is of a much lighter colour than the rest, the middle being concretionary in structure, and the lower sandy. These three beds, with the overlying white sponge-bed, were considered to belong to one formation, and were treated of in this paper as the Hunstanton Rock; but the thin band of red chalk some distance above was considered, though of similar colour, to be quite distinct, as also was the Carstone below.

Mr. Seeley then showed that near Cambridge the Shanklin sands and the Gault have both become very thin, so that there is a great probability of the latter being unconformable to the beds above as well as to those below. He considered the lower part of the Carstone to be of the age of the Shanklin sands; and as the chalk is not unconformable to the Hunstanton rock, he concluded that the latter could not be the Gault, but must be the Upper Greensand,—a conclusion which he afterwards showed was supported by the evidence of the fossils, and the occurrence of phosphate of lime.

The seam of soapy clay which separates the Hunstanton rock from the chalk was supposed to have resulted from the disintegration of a portion of the former, the red colour of which the author endeavoured to show was due to Glauconite.

The upper part of the red rock of Speeton was thought to be possibly newer than that of Hunstanton, and perhaps to represent the time which elapsed between the formation of the latter and that of the band of red chalk.

In conclusion, Mr. Seeley remarked that as the phosphate of lime is confined to Bed No. 2, and as many individuals of Gault species occur in Bed No. 3, while others of a chalk character are met with in Bed No. 1, it is very probable that the Hunstanton rock is a more typical example of the Upper Greensand than is seen at Cambridge, and may represent also those periods which separate that formation from other divisions of the Cretaceous system.

FOREIGN INTELLIGENCE.

On some Mammalian Remains from the Neighbourhood of Vienna. By Dr. Zittel.—A beautifully preserved upper jaw of *Anchitherium Aurelianense* has been found in the brown coal of Leiding, near Pitten (south of Vienna). Since the late Mr. Partsch some years since stated the occurrence of this remarkable species in the Neogene limestone of Brack, on the Leitha (south-east of Vienna), it has not been found within the basin of Vienna. The jaw under notice, an inferior tooth from the marine sands of Grossbach, and an upper tooth from the brackish "Tegel" of Nussdorf (west of Vienna), prove this animal to have occurred in each of the three periods during which mammalia made their appearance within the Vienna basin.

On some Upper Cretaceous Cœloptychia. By Director Hörnes.—Mr. Grotrian, of Brunswick, has presented the Imperial Museum of

Vienna with a series of five species of this genus of Spongiaria (*Cœloptychium agaricoides*, Goldf., *C. deciminum*, Roem., *C. incisivum*, Roem., *C. subciferum*, Roem., and *C. lobatum*, Goldf.), all of them beautifully preserved and prepared with uncommon care. These fossils occur near Vordorf, two hours' distance north of Brunswick, in a mass of Upper Cretaceous Limestone, which at places appears through the uniform diluvial deposits characteristic of the extensive plain of North Germany. *Belemnitella mucronata*, D'Orb., *B. quadrata*, D'Orb., *Micraster coranguinum*, Lam., and *Ananchytes ovata*, Lam., are the characteristic organic remains in this limestone. Cœloptychia are not exclusively confined to the upper or Belemnitella-horizons of the Cretaceous deposits. The rarest among them are *C. incisum*, *C. sulciferum*, and *C. lobatum*.

ON THE BAYREUTH SANDSTONES. By Professor Gümbel.—These sandstones, remarkable for the abundance of fossil vegetable remains preserved in them, are equivalent to the bone-bed strata of Würtemberg. They are, in every locality hitherto known, invariably overlaid by the normal lowest Liassic strata, with *Ammonites angulatus*, *Thalossites*, etc. These passage-beds, which are neither decidedly Keuperian, nor properly Liassic, would be best distinguished from both by the special denomination "Rhætic division."

ON SOME NEOGENE FOSSILS FROM TRANSYLVANIA. By Chev. Fr. Ritter von Hauer.—Mr. Rang has presented to the Museum of the Imperial Geological Institute a series of organic remains from the argillaceous sphærosiderite of Biharcz falva (Transylvania), metamorphized into brown hydroxide of iron. Among them are many specimens of a Congeria (*C. triangularis*, Partsch), and a cast of a Paludina (*P. Sadleri*, Partsch), proving once more the lignitiferous and ferriferous basaltic breccias of Transylvania to be geologically equivalent to the Neogene Cerithian strata. (Proceed. Impl. Geol. Instit. Vienna, May 19 and Dec. 1, 1863.)*

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* The above notes are communicated by Count Marschall, of Vienna.

REVIEW.

Popular Geology of Darlington. By R. T. Manson, Vice-President Naturalists' Society. 'Darlington Times' Office, 1864.

This little work is in pamphlet form, containing thirty-two pages; and consists of six articles, originally written for the 'Darlington and Stockton Times,' in 1860, which, having been altered and enlarged, are now reprinted. The first chapter is devoted to the "Bulmer stone," in Northgate—a famous granite boulder; the second, to the quarries near Sheldon station, worked in the "Stinkstein" and Permian beds; the third, to the coal strata of Thukley and Sheldon; the fourth, to the great Whin Dyke; and the fifth, to the Trias of Darlington itself. An appendix, giving the localities for fossils, is added; and acknowledgments to Mr. Howse, of Sunderland, Mr. Janson, of Darlington, Mr. Edward Wood, of Richmond—the last of whom possesses a most valuable collection of fishes from the locality described—brings this useful, instructive, and popularly written work to a close. Such local books can but induce to spread a taste for research and the collecting of fossils. We hope the sale will remunerate the author and publishers.

THE GEOLOGIST.

JUNE 1864.

THE PRIMARY TRANSLATION OF THE EARTH.

By the Editor.

In reference to the correspondence on my speculations in theoretical geology and astronomy which have been printed in this Journal, I wish to take this opportunity of saying, that if in the cases of the Rev. O. Fisher, p. 54 in this volume, and of Dr. Leslie, p. 295 in Vol. VI., I have inserted such comments on any of the physical hypotheses to which from time to time I have given expression without replying to those comments, that I do not therefore acknowledge my opponents to be right, nor, on the other hand, do I intend to pass them over slightingly as wrong, or as unworthy of attention. I simply thought it best not to get into controversy *while* my own ideas were being enunciated. I cannot, however, concur in the Rev. O. Fisher's views as to the possibility of the earth's velocity, if initial primarily, being maintained, nor of a larger orbit for our planet being a result of any retardation of her motion. I am well aware of Kepler's law referred to, and I have my own opinion both of its value and its application. Mathematics may derive a result from a given basis, but mathematics never yet gave birth to a basis of facts. That two added to two make four may be mathematically demonstrated, but no amount of mathematical reasoning would prove four to be derived from two and two. It is evident it might have been derived from 3 + 1, or 1 + 1 + 1 + 1. Just so if the orbital velocity of our earth had been imparted to it by explosion, by condensation, by any *projectile* force whatever, its tendency of motion must have first been in a *straight* line; and as the projectile-force would have been greater at its origin than after ages upon ages of retardation, the earth would therefore primarily have had a greater antagonistic force to the attraction of the sun, and the higher the centrifugal force, the greater the expanse of her orbit. The more we twirl a mop the more it spreads, and no amount of Kepler's laws, or anybody else's, would get over the physical fact, or convince people against their eyesight or their senses. Astronomers *must* make their calculations and predictions upon *definite* forms, such as circles, ellipses, parabolas, parallelograms, and so forth. They must *assume* these if they do not exist—and they do not. But there is no astronomical calculation rigidly correct, and the slightest deviation is fatal to the doctrine of the permanence and fixity and unalterability of the celestial mechanism and planetary motions. There is no such fixity. All is change everywhere through boundless space—slow, elaborating, perfecting; altering, changing, destroying—change—like life and death—everywhere without exception.

To return to the point asserted, that "if the distance of a planet from the sun be increased, the velocity in the orbit will be diminished." If the velocity of the earth be due to a primary projection, that projection could not have been *circular;* there is no such force as circular projection known. We cannot shoot round a corner even with a bent gun. Therefore if the earth's orbital motion be due to any original projectile-force, the primary direction of the earth's course must have been *direct;* and this normal course can only have been turned into a circular revolution round the sun by the sun's *superior* attractive power. If, then, the *superiority* of the sun's attractive power over the earth's direct motion be *increased* by the *diminution* of the original projectile-force through ages of slight resistance by the ether of space, then the *ever-increasing difference of that superiority* will ever and ever be *reducing the orbit* into closer and closer proximity to the central attracting sun. Thus therefore it is evident that if the world acquired its orbital motion, or rather its translation through space, by any explosion, or condensation of nebulous matter, or any other source of *projectile-force*, its orbit must be a constantly increasing or a constantly diminishing *spiral.* It is quite evident also that if the earth did possess any given and definite initial velocity, that velocity *must remain the same*, unless affected and diminished by the resistance of the medium through which it travels. If one hundred miles a second were the initial velocity of the earth, removing the earth's orbit to the confines of celestial space could not increase that velocity by a mile, an inch in a second, if the resisting medium remained the same. The force that started gave the velocity, and the earth must get an additional kick, so to speak, while running, to have its orbital velocity increased. Now force acts *equally in all directions;* and if a grain of gunpowder were exploded in mid air, it would blow out in all directions alike. So if any explosion or explosive condensation of nebulous matter took place in space, it would act in all directions alike; it would be a sphere of explosion, or a globular result from the condensation of matter within a given spherical area of space. The motion of such an explosion would be like sunlight radiating in every direction; the motion produced by such a condensation would be exactly the reverse, or like the crushing in-rush of air into an exhausted globe of glass—an incoming to a central spot from all around. Neither explosion nor condensation in space could give rise to projectile-force; and if therefore this world *was* formed by the condensation or the explosion of nebulous matter, neither that condensation nor that explosion could cause the translation of our resulting earth from one part of space to another. There could be no projection of a world in space *without a wall or fulcrum of denser space for the projecting force to act against.* A cannon ball could not be projected from an open tube; the gases of the gunpowder in the cannon act against the breach and find a fulcrum there. Where are gases exploding in open celestial space to find a wall of resistance that shall give the explosion a projectile-force? We cannot conceive. Neither explosion nor condensation therefore could give rise either to direct or to revolutionary orbital motion round the sun; it is impossible. It even seems more natural to seek for the causes of planetary orbital motion in motions of the ether of space. The incandescence of the sun must put any ethereal matter surrounding it for millions upon millions of miles around in a state of intense vibration. If the sun be in combustion—and spectral analysis shows it to be—oxygen or some other combustion-supporting gas must, one would fancy, be constantly indrawn towards it; while the heated and unburnt particles of the ether of space, or of the products of combustion, would as constantly be driven out into space. Might there be thus produced in the circumambient area around our luminary constant in-settings and out-settings of gaseous particles the friction of which against a free spherical planet might effect a rotatory motion of it? If so, would the length of day and night depend on the strength of these settings? If the supply of fire-supporting gases swept in grand spiral currents to the central burning sun, would the planets float in these currents in spiral orbital revolutions? *Then*, indeed, Kepler's law would hold good that the further from the sun the *slower* the orbital motion. But with an original projectile velocity that result could never happen.

FOSSIL BIRDS.

By the Editor.

(*Continued from page* 53.)

It is certainly very much out of stratigraphical order to jump from the fossil bird-remains of the Stonesfield Slate to those of the Tertiary beds of the Paris basin; nor is such a step in any accordance with historical order. We are simply compelled to take it, through the necessity of saying a few words in explanation of certain plates which have been issued with the previous numbers of this volume. The gap, however, in the historical series is not so very wide; and it is by no means useless in this place to run over afresh the review which the great Cuvier made of the labours of his predecessors. A section of vol. iii. of his famous work, 'Recherches sur les Ossements Fossiles,' published in 1812,* was devoted to the remains of birds. "Naturalists," he begins, "are agreed that, of all animals, birds are those whose bones or other relics are the most rarely found in the fossil state. Some even absolutely deny that any have ever been met with; and indeed, by one of those singular accidents reserved for the beds of gypsum of our neighbourhood, there are scarcely any other well-preserved fossil bones of birds than those they have furnished." He then, to show the correctness of this statement, and the then recent knowledge even of the fossil birds of the *plâtrières* of Paris, glances over the statements of Walch, Hermann, Camper, Blumenbach, Faujas, Lamanon, Gesner, Luid, Wallerius and Linnæus, Davila and others, the accounts of most of which have been already given in our previous articles.

"Walch, he says, "had met with several; Hermann added others. Their indications serve us as guides, without however exempting us from going to the original; for the first deceives himself many times in spite of this precaution." Conrad Gesner, he observes, early declared that the stones named after birds, such as the *hiéracites* and the *perdicites*, had no other affinity with them than resemblances of colour; but "rude figures of birds," he adds, "accidentally traced in coloured stones, certainly do not properly belong to the Ornitholites,

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* We quote from the 5th edition, published in 1835.—S. J. M.

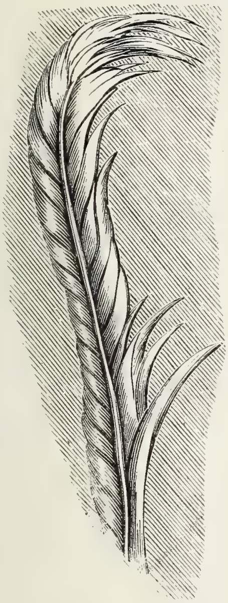

Fig. 1

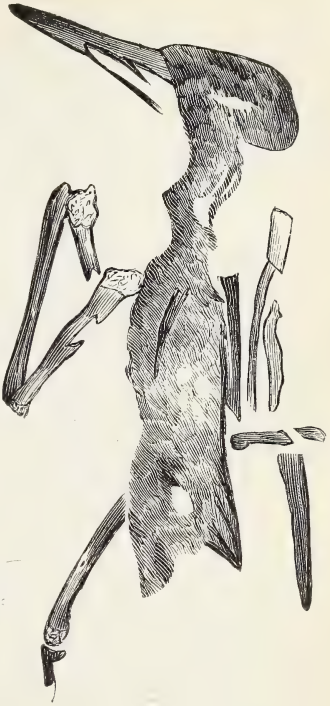

Fig. 2.

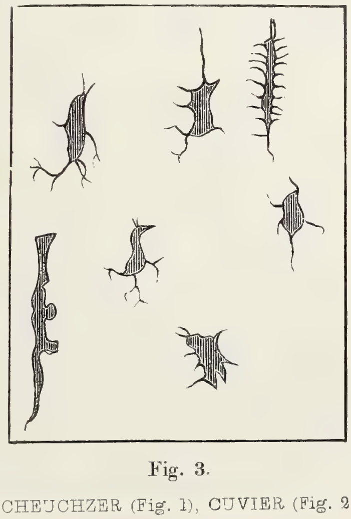

Fig. 3.

FOSSIL BIRDS, FROM SCHEUCHZER (Fig. 1), CUVIER (Fig. 2), AND EMMONS (Fig. 3).

any more than stones or pebbles having some sort of similitude to parts of birds, such as the 'cock' of Agricola and the 'hen' of Mylius, imprinted on the schist of Illmenau. Other authors have also," he continues, "regarded very gratuitously as Ornitholites some fossil bones, merely on account of their lightness and slenderness, but which a very slight examination would suffice to prove those of fish, small quadrupeds, and sometimes even to be parts of shells and crustaceans."

"Thus the *sulcata littoralis rostrata* of Luid (Lith. Brit. t. 17) appears to me but the extremity of the dentated spine of the fin of some fish. The 'beaks' of the environs of Weimar and Jena, of which Wallerius and Linnæus speak, are only, according to Walch, who has been in that country, but superficial resemblances. Rom. Delille, in the Catalogue of the Cabinet of Davila, cites a beak from the environs of Reutlingen (Cat. iii. p. 225), which has been adopted by Linnæus, and a bone from Cronstadt, which appeared to him to be a fowl's; but his 'beak' seems to be only a bivalve shell showing itself obliquely at the surface of the stone. If it were a true beak, it differed prodigiously from all that we now know of existing birds; and as to the bone, there is neither description nor figure in his work. Scheuchzer speaks (Mus. Dil. p. 106) of a bird's head in a black schist of Eisleben; but he adds immediately, that 'one might also take it for a gillyflower,'—quite sufficient to judge it by. Others (Lesser, *Lithothéol.*, Wallerius) quote the description of the environs of Massel by Hermann, as if he there spoke of bones of birds; but that author really announces only *little bones*, without saying that they may be those of birds. The error of compilers with respect to the petrified cuckoo (*coucou*) of Zannichelli * is still greater and truly funny. He alludes to the fish *coucou*, a species of Trigla (*Trigla cuculus*, Linn.; in Italian, *pesce capone*), and not to the bird. Other reports have neither descriptions nor figures sufficient to justify them. Such is that of Volkman, in his 'Silesia Subterranea' (p. 144), and those brought forward by the systematic mineralogists. . . . It is clear that incrustations do not belong to our subject; and if the accounts of them were all true, they would prove nothing as to the existence of Ornitholites."

There remained then, after these eliminations by Cuvier, in the works of previous authors only the relics in certain schists, such as those of Œningen, Pappenheim, and Monte Bolca, which could have any claims to a serious examination, and which could really have been taken for Ornitholites by thorough naturalists.

"Now," says Cuvier, "nearly all that has been cited is more or less equivocal, or, at least, is not substantiated by sufficient figures and descriptions. These schists abound in all sorts of fish and other products of the sea; the bones in them are compressed. Who would dare to flatter himself as being able to distinguish in this state a fish-bone from a bird-bone? The feathers even, are they easy to be distinguished from the Sertulariæ? How, then, can an inconsiderable portion be judged of, such as a member? The best authority for an investigation of this kind undeniably should be that of M. Blumenbach; but he limits himself to saying, that there have been found at Œningen *bones of littoral birds* ('*os d'oiseaux de rivage*'), in Mém. d'Hist. Nat. (Trad. Fr.) ii. 408. As to those of Pappenheim, he refers to the Memoirs of the Academy of Manheim (Act. as Theod. pal. v. pars, phys. 63); but it is surely questionable, from the locality given, whether it may not be a very singular reptile, of which we shall speak hereafter (our Pterodactyle), and not, as M. Blumenbach calls it, a *palmipede bird.* Zannichelli had what he called a 'beak' from Œningen; but was it more real than that of Davila?"* Scheuchzer cites a feather from the same place (Mus. Dil. p. 106; Pisc. Quer. p. 14; Phys. Sac. i. t. 53, f. 22); but he did not convince Fortis, who believed it was only a Sertularia (Jour. de Phys. flor. an viii. p. 334); nor Hermann, who, he says, is always ridiculing this pretended feather (*op. cit.* p. 340). We should have them under our eyes to judge. Fortis was not more convinced of the examples of feathers from Monte Bocla, which he saw at Verona (*op. cit.* p. 334), two of which have been published by M. Faujas (Annales du Muséum d'Hist. Nat. vol. vi. p. 21, pl. 1). I confess, however, that if there are any portions able to carry conviction, they are those which I have examined with the greatest care many times, and in which I can discover no character whatever to distinguish them from feathers (*des plumes*). But, in supposing they may be such indeed, they would prove nothing against my previous assertion; there have been none as yet well preserved, except in our gypsum."

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* Dargentville, Or. p. 333, and Walch, Com. sur Know. ii. p. 11.

Cuvier then refers to Lamanon's description, in 1782, of the bird found at Montmartre by M. Darcet, and of which he admits there can be no doubt. He notices, however, that Lamanon has put in the feathers of the wings and tail, and has unfortunately given his imagination a little play; he insinuates, also, that the drawing is not very like the original. He moreover tells us that Fortis, who had conceived strong prejudices against the existence of Ornitholites, examined afresh what had been described by Lamanon, and gave a figure according to his own ideas; thereby affording a very remarkable illustration of the degrees of difference the same object may assume under eyes that regard it in a different aspect. "We can distinguish nothing," says Cuvier, "in the figure given by Fortis; the head is upside down, all the inequalities of the stone are exaggerated, the osseous imprints weakened; in short, the author declares he can see in this fragment only a frog or a toad."

The fact is, however, as Cuvier states, and there can be no doubt at all that this specimen is a veritable ornitholite.

"But," he adds, "one could hardly have dared to sustain it if there had not since been found in our plaster-works pieces more characteristic and suited to confirm it. Peter Camper mentions one, but without describing it, in an article on the fossil bones of Maestricht, published in the Philosophical Transactions for 1786. It is a foot found at Montmartre, of which M. Camper, jun., has sent me a drawing, which I have had engraved in the 'Bulletin de la Société Philomathique,' for Fructidor, An VIII. I had myself a second piece, also a foot. This was from Clignancourt, below Montmartre. I described it in a note read before the Institute the 13 Thermidor, An VIII., and published in the 'Journal de Physique' of

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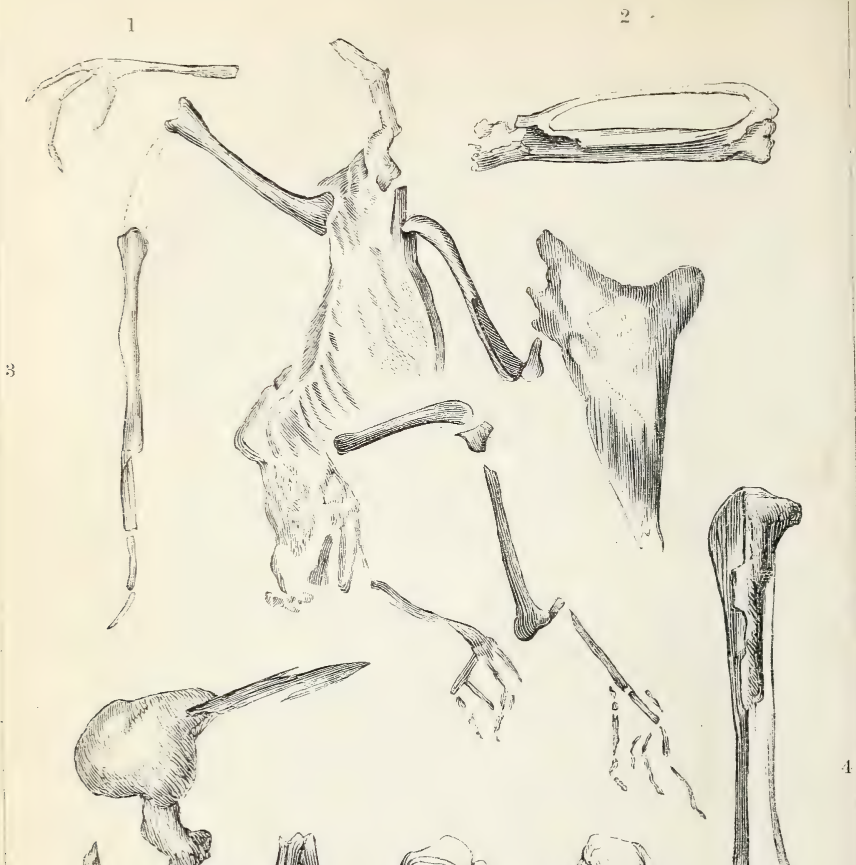
* Was not the aptychus of the Ammonite sometimes noticed under the term "beak" by some of the old writers?—S. J. M.

PLATE VI.



FOSSIL BIRDS FROM THE PARIS BEDS.

the same month, p. 128, etc., with an engraving (pl. i.), which was reproduced in the 'Bulletin de la Société Philomathique,' for Fructidor, An VIII., and afterwards in different foreign journals. On this occasion I learnt there existed two others in the hands of a private person at Abbeville, M. Elluin, engraver, who had also received them from Montmartre; and M. de Lamétherie gave a copy, in the same number of his Journal (pl. ii.), of a drawing sent him by Mr. Traullé. It was the body of one bird and the leg of another. It was easy to see that the leg did not belong to the same individual, and also that the incrusting stone came from another bed. Such is the judgment of MM. Baillet and Traullé (Journ. de Phys. Therm. an viii. p. 132), which M. de Burtin confirms in a note to a description of this fossil, published by M. Goret, of Abbeville (Trs. Soc. d'Emulation). Having had the specimen for some time under our eyes, we have assured ourselves of the correctness of this fact. There have been, then, since 1800, four different well-marked fragments; that of M. Darcet makes the fifth. Since then I have continued my researches, and have found such a great number that there can be no longer any doubt that our plaster-beds contain many remains (*beaucoup de débris*) of birds."

These specimens, which he had collected, Cuvier then goes on to describe, beginning with the feet, "as being the most striking parts even for least accustomed eyes." "Indeed," he continues, "the foot of any bird whatever is composed in an absolutely particular manner, and does not resemble that of any other animal."

The specimens of fossil birds from the environs of Paris figured and described by Cuvier are:—

"1. A very complete leg and foot of a common species from the Gypsum (vii.)*; 2, end of tibia and foot complete of same species; 3, foot of bird from M. de Lamétherie's cabinet (vi.); 4, fragments of the foot of a bird, showing the first phalanges of the thumb and outside and middle digits, probably the same species as No. 6 (iv.); 5, inferior mandible; 6, copy of Elluin's specimen; 7, tarsal bone of a bird of the same species as No. 11; 8, leg of bird, showing the entire tibia, the thumb, and three other digits very complete (vii.); 9, foot of bird of same species as No. 11 (v.); 10, bird's foot described and figured by Cuvier in 1800 (viii.) allied to (vii.) species, and of the order *Grallæ* (storks and herons); 11, leg and foot of a bird much smaller than No. 4 (v.); 12, Darcet's specimen, a different species from any other (x.); 13, the two sides of a badly-preserved body, M. Elluin's specimen, drawn by Cuvier; 14, phalange of a bird's foot of a larger species than any of the others (i.); 15, portion of the wing of a bird, with the end of the humerus, the cubitus, the two carpal bones, the imprint of the apophysis of the metacarpal bone carrying the thumb and the imprint of a part of another metacarpal; 16, portion of wing in the cabinets of M. de Lamétherie, allied to the sea-larks (*Pelidna*, Cuv.) (viii.); 17, rib of fossil bird; 18, radius; 19, radius (x.); 20, humerus of littoral bird, anterior and posterior faces (iv.?); 21, humerus (ix.); 22, humerus (ix.); 23, end of omoplate of a bird resembling, in diminutive, that of a cormorant; 24, femur of a bird near to the genus *Pelican*; 25, femur of a bird of the order *Grallæ* and the genus *Ibis*; 26, portion of the trunk and both wings, and femur of a fossil bird (ix.); 27, well-preserved ornitholite from Montmartre, of the family *Gallinaceæ* (v.), showing the under-beak, its right ramus nearly entire, portions of both sides of the base of the cranium, vertebræ of neck, right clavicle, and parts of the left, small portion of the omoplate, the sternum much crushed and disfigured, and an equally disfigured impression of the pelvis, the tibia, and many other intelligible parts; 28, the four phalanges of a medius of a bird of prey, like their analogues in the buzzard (ii.); 29, lower mandible; 30, a 'frog-bone' (junction of the two clavicles); 31, coracoid bone; 32, another coracoid; 33, metacarpal and phalanges; 34, inferior mandible of a bird (v.); 35, humerus (v. ?); 36, another humerus; 37, small humerus of (x.) and 38, leg and foot of the same species, No. 33; 39, small bird's foot (ix. ?); 40, metacarpal of bird of prey of large size, and with long wings of the dimensions of the bald-buzzard, probably the same species as No. 24 (xi.); 41, another metacarpal of a bird of prey, much smaller, and having much shorter wings, probably of the same species as No. 48; 42, skeleton from Montmartre (ix.), the wing extended, humerus nearly entire, sternum crushed, feet and right leg well shown, as are also other bones; 43, well-preserved and characteristic skeleton from Montmartre, of the same species (ix.) as the foregoing, showing the head and beak, portion of the 'frog-bone,' back-bone, ribs, wing-bones, legs and feet, and other parts, very little disturbed from their natural condition; 43, mutilated humerus of a singular species, and like that of the screech-owl; 44, radius; 45, well-preserved foot; 46, badly-preserved foot of same species as No. 11 (v.)."

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* The Roman numerals indicate Cuvier's species. Cuvier did not assign any names to the species he indicated.

It will be seen then that Cuvier founds on these bird-remains no fewer than ten species. His first on the foot, described by him in 1800, in which the thumb or hind-toe is wanting (No. 10); but we see in the specimen the little bone, which carries it in many birds. These characters are much more complete in No. 8; the femur in that specimen is wanting, but the tibia is much more entire, and the thumb and the three other digits are very complete, and furnished with all the articulations they ought to have; the foot of this specimen having the tibia and tarsus a little longer than the first, is made another species by Cuvier. Of M. de Lamétherie's specimen, Cuvier makes a third species; of M. Elluin's a fourth; of the foot No. 15, which he thinks somewhat smaller than the last, a fifth; of No. 38 a sixth; of the four phalanges forming the medius of a bird of prey, No. 28, allied to the buzzard, a seventh; of the phalange of the great bird, No. 14, an eighth; and of the small foot, No. 39, a ninth species, all founded on the débris of the walking limbs alone. He founds three other species on the beaks in Nos. 5, 29, 39, respectively. We can scarcely analyse further Cuvier's work without giving additional figures, which our fast-closing limits will not allow. We can therefore only add that our Plates give examples of—No. 43 (Pl. III., fig. 1); No. 42 (Pl, VI., fig. 3); No. 41 (Pl. VI., fig. 2); No. 39 (Pl. VI., fig. 1); No. 25 (Pl. VI., fig. 4); No. 20, anterior and posterior views (Pl. VI., fig. 5); No. 15 (Pl. VI., fig. 7); No. 13 *a* (Pl. VI., fig. 6); No. 13 *b* (Pl. IV., fig. 2); and regret being cut off in the middle of our survey of the bibliography and present state of ornithological palæontology, the only manageable portion for anything at all like concisely showing the very imperfect state of our present knowledge of the past history of organic life on our globe.

ON THE GLACIAL DRIFT OF FURNESS, LANCASHIRE.

By Miss E. Hodgson.

The following sketch of the glacial deposits of Furness is not pretended to be complete; it is, in fact, nothing but a sketch: neither can it presume to be free from errors. The marine drift, especially, has not received all the attention it demands, but will, I hope, with the clays and peats of Furness, form a subject for a future memoir. The deposits in the section are referred *doubtfully* to their periods.

Striated Rock Surfaces.—The district of Furness; its south-eastern part, however, does not perhaps present so many of those remarkable records of the glacial period, the striated rock-surfaces, as are to be met with in more mountainous districts. The rocks, especially the Carboniferous Limestone and Permian formations, either lie in a great measure hidden under a thick covering of deposits, or, as in the hills of the Upper Silurian strata, are of such a soft decomposing nature, that they retain very little primitive facing.

Occasionally, however, striations may be found. A little way in shore, west from the estuary of the Crake, at the head of Morecambe Bay, a rock-surface recently exposed by the removal of the overlying material, and now quarried away, showed a series of parallel shallow groovings from an inch to an inch and a half apart; the intervening spaces plane and smoothed, and having very fine striæ. The striæ and grooving had a direction from E. to W., or perhaps a little N.E. to S.W. The rock presented an extraordinary and beautiful appearance, with no signs of fracture, but on attempting to break off a specimen, it was found to be literally crushed to pieces as if it had been an egg-shell: so that no specimen exhibiting more than one groove and smooth space could possibly be obtained.

South of this, and still not far from shore, but with a hill of more than 300 feet elevation lying between, striæ are found taking a S.W. by S. direction. The same occurs very distinctly on other spots near. Further west, on Ben Crag, a hill of nearly 500 feet elevation, the same N.E. by N. and S.W. by S. striation is observed, protected by the grassy sod.

It is found again with a very little variation on the Carboniferous Limestone, where it underlies the Boulder-clay on the shore between Bardsea and Aldingham. Some exposed beds of the limestone, levelled off and polished, have it very persistently, in fine parallel lines, now nearly worn out by the sea.

This direction of striæ corresponds with the general trend of the hills of Furness, as well as with the line of the centre of Morecambe Bay. But even where this is not the case, where the strike of the hills, so to speak, is N.W. and S.E., with a narrow vale or channel lying between, the striæ will be found having the same undeviating direction right across from N.E. by N. to S.W. by S. This is exemplified in the hills bordering the vale of Newland, near Ulverstone, where a brook now runs from 300 to 400 feet below the heights on each side. There is no question, however, but that the gill is deeper than when the ice crossed it, but the striation is repeated on the N.E. side down to 275 feet from the top, and at rather more than 125 feet above the brook; while it is a curious fact that this happens to be about the elevation above the brook, of the lowest obtained striæ on the S.W. side.

At the same time, although this is very likely to be the prevailing tendency of striæ in Furness, yet there are exceptions, and a slight deviation will sometimes occur between two points within a short distance of each other. Thus, on Gameswell Hill, deep groovings pass from N.N.E. to S.S.W., while rather more than half a mile off the striation is from E.N.E. to W.S.W. Yet neither of the two striations can have any connection with the present features of the locality. The gill that passes under Gameswell on the west cuts directly N. and S., and the rocks with the latter striation are on the south-eastern slope of a fell, down which small drainage depressions pass to the E. and S.E.

It should be conceded, I think, to the inexperienced student, that there may be great difficulty sometimes in selecting glacial striæ out of "weathered" lines of cleavage and stratification in the slate rocks. The difficulty is not when they present their edges sharp, close, and regular; but when *e.g.* somewhat resembling the spreading leaves of an opened book, they have been further worn into horizontal hollows, ruts, or grooves; and this, possibly, by the glacier passing over at right angles to them, rather than parallel with them, as would be at first suggested. The above is only one out of other instances of deception met with on decomposing slate rocks. It must occasionally happen that true striæ may run parallel with either the cleavage or bedding; but in these doubtful cases I have uniformly abandoned them, and it is not unlikely that good genuine striæ, which the experienced geologist would have noted down, may thus have escaped.

On the craggy heights of the moors, as well as in some places on the shore, the aspect of the rocks indicate that the principal denuding force has been carried over from the north. They generally present their smoothed sides to the north or north-east, their rugged ones to the opposite point; deep ruts passing up the smooth incline answering in point of depth to the opposition that incline had presented. In some instances the edges of the cleavage planes have been so shaved off, grooved across at right angles, and rounded, as strikingly to resemble the laminated structure of a shell-hill contour.

With regard to the form and outline of many of our hills, the beautiful description given at some length by Mr. Geikie, of the glaciation among the mountains of Scotland, might well serve for a description of these. Indeed, so truly do the glacial footsteps tell the same tale everywhere, varying only in degree of magnificence, that it would seem there can be only one set of terms happily and faithfully to record it in. Furness is not without "that union of prominent yet rounded crag and gently curving hollow which indicates the passage of the ice-sheet, with hardly less clearness than the ripple on the shore tells of the retreat of the sea,"* and lit up by the slanting rays of the evening sun, assuredly it yields nothing in point of interest and loveliness to the prouder types of Scotland. Besides being of frequent occurrence on our moors, this feature is especially conspicuous on the hills at Newland, and from thence, obscured a little by plantations to the head of the bay, where it again becomes traceable up the valley of the Crake. It first arrested my attention and had its true cause assigned to it in my note-book, after visiting in the autumn of last year the Roches Moutonnées in the vale of the Rotha at Ambleside, described by Mr. Hull,† and cited by Sir C. Lyell in his 'Antiquity of Man.'‡ "When a geologist," says Mr. Geikie, "has once familiarized himself with its varieties even in one locality, there are not many landscapes in the country where he will fail to detect its presence."

Roches Moutonnées.—True Roches Moutonnées lie on the eastern outskirts of Ulverstone. There is one close to the railway viaduct over the canal; it has been quarried, but still retains much of its remarkably rounded form. Another in the peat-mosses on the N.E. of the canal, is buried under the railway embankment; the domed top long refused to afford good foundation.

Stream Valleys.—In a deep narrow gill of the Silurian strata, close to Ulverstone, the striation seems to denote that the glacier in its progress has taken the curve of the gill, as it swerves from W. by N. and E. by S. to N.W. by N. and S.E. by S. It is difficult to fix the amount of glaciation in this gill; rocks of Devonian age have been swept out, but to what extent they may have been developed it is impossible to guess. I have always associated its glaciation in point of age (whether correctly or not I cannot say), with the forming of some remarkable indentations on the moor of Osmotherley, about a mile distant. These miniature glens, as they might be called, are deep, dry, parallel hollows, having a N.W. and S.E. direction, converging a little as they descend the moor-side, and fall into the drainage line leading to Ulverstone. Doubtless they differ little in character from many other depressions on the moors, but the singular, almost mural outline, they assume on the horizon is very arresting to the eye, and although they may mark the course of occasional rivulets, yet it is scarcely likely they are water-formed unaided by ice. As yet, however, no striæ have been detected in them. The crags in the vicinity are greatly crushed, a circumstance not altogether to be assigned, I believe, to atmospheric agency, either in this or any of the numerous instances of crushed strata on moors. Most of our stream-valleys, doubtless, owe their present features to the softening of the climate and the final melting down of ice; a transition not wholly insignificant in its effects even here, when we regard those escarpments of deposits, whether marine or glacier-formed, which tower loftily along many of their lines, sometimes on one side, sometimes on the other, and individually faced, perhaps, by a gentle verdant slope, that, with the gurgling brook below, seems to hide, as it were, under a calm disguise, all the tumult of the past. One of these escarpments on the line of the Pennington Beck is crested by "hummocks" of boulder clay, so artificial in form that tradition holds them as the site of an ancient castle, a half-encircling hollow, apparently water-formed, answering for the remains of the castle-ditch. I have an impression that geologists familiar with the phenomena of the period, would experience little difficulty in assigning this (together with much of the physical aspect of that truly interesting vicinity) entirely to glaciation and its subsequent modifying agencies. Almost every stone and pebble about the place is wonderfully grooved and striated.

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* Geikie, 'On the Phenomena of the Glacial Drift of Scotland.'

† Hull, Edin. New Phil. Journal, vol. xi. p. 31, 1860.

‡ Geol. Evidence of the Antiq. of Man.

The other features of our stream-valleys are the stripes or terraces which at various elevations and distances mark the former river-possessions, inasmuch as when tried by the spirit-level, they are found to be on an extremely gentle incline, thus affording additional evidence that all our brooks have been rivers, and our rivers mighty streams. Deposits of river-gravels occur at some heights above the present brooks, as in the vale of Newland before alluded to. There deposits of dark gravels and sands lie in underneath the hillside boulder clay, while the latter appears to have been scooped out by the flow and wash of the down-passing current, into a true overhanging river-bank, 50 feet above the bed of the present stream.

Boulder clay.—In slightly sketching out the position of the boulder clay in Furness, what knowledge I have of the nature and composition of that deposit is mainly derived from the teaching of the admirable memoir before referred to, 'On the Phenomena of the Glacial Drift of Scotland,' aided by the close examination of numberless specimens obtained from many localities. Its *stones and boulders rounded, angular, flattened, smoothed, striated, seldom of remote transportation, disposed without stratification in a more or less clayey material*, are the characters by which it may be distinguished here. But there are other peculiarities of the boulder clay in Furness for which the above work somewhat prepares the student. These are the bars, thin seams, or beds of gravels and sands, which very frequently are found running through it. These are neither fluviatile nor marine; they precisely resemble in lithological character the true boulder clay in which they occur: the stones, in some instances at least, have scarcely lost their striation, and clearly owe their stratified disposal to the percolation of water. In fact, such beds must have been simply melting zones in the heart of the glacier. Sometimes they rest upon the rock surface under the boulder clay, at others they alternate with it in more or less equal thickness throughout its depth, and occasionally they are found lying next the surface-soil. No doubt by being now, what they became then, passages for water, they are constantly and gradually extending themselves into the hard substance of the boulder clay.

By obtaining rough sections of numerous well-sinkings in the boulder clay, under the town of Ulverstone, a pretty accurate knowledge of these stratified beds is arrived at. They are known to the sinker as waterbars, and are, I think, identical in character with those seen in section on the moors, and in the Furness railway cutting. They are often found dry: hence several are passed before one containing water is reached.

They are described as having an average dip or incline of one quarter of an inch in five feet. The gravels lie between yellow sandbeds, which are smooth on their interior surfaces (*i.e.* the surfaces in contact with the gravels) and very compact. The pebbles are chiefly "*bright-blue*" (Silurian). Occasionally granite pebbles occur, and have this peculiarity, that the beds containing them are seldom more than two inches thick. The boulder clay is said to shade off gradually in colour from the yellow sands to that of its own, which is generally bluish, though occasionally other tints prevail. Under the west of the town the boulder clay is so hard as to break the pick point, is very dry, and free of gravel seams for a great depth.

This interesting deposit occurs in patches on our hills, is spread more thickly on our moors, descends next the rock-surface into the vales, forms fine sections on our south-eastern shores, and declines down under the marine stratified drift, at the southern end of the promontory.

At the Lindale moor iron mines, a good section of nearly half a mile is displayed by the sinking of the ground since the removal of the underlying ore. The following measurements were taken for me in two places along this section:—

	ft.	in.
Soil.		
Boulder clay	5	0
Sand and gravel	2	6
Boulder clay	3	0
Soil.		
Boulder clay	6	0
Sand and gravel	2	0
Boulder clay	9	0

There is a pretty general uniformity in the upper deposits throughout the length, but in some parts the lower boulder clay attains a much greater thickness. The gravels dip gently to the south-east. In long dry weather the laminated sands become inconspicuous; but here and there a red tinge pervades the series and denotes the occasional presence of water charged with iron. The boulder clay here is of a dark ochreous colour, in fact, just the colour of the highly decomposed Silurian pebble, and seems perfectly to answer to its final débris. The stones in good preservation, are much striated, and the boulders beautifully smoothed and grooved. In this *arena*, encircled partly by rock (Silurian) with boulder clay in section, and partly by the refuse heaps, the student of glacial phenomena may find ample occupation. Ice-scratched boulders of limestone and intercalated iron-ore, are there thrown to light; while lying out exposed, are huge blocks of the former, marvellously cut and hacked in every possible direction. The effect of turbid water upon stone is shown here. The limestone blocks within its influence have undergone great decomposition, and are moulded down into grotesque figures and shapes, similar to what are seen on the surface of limestone commons, and used for ornamental rock-work. Their surfaces are rough as sandstone, coated with a fine, almost impalpable, red powder. They are imbedded in a dark brown substance, probably "Black Mack," described by Mr. Cameron, vol. xix. page 27 of the 'Quarterly Journal of the Geological Society.'

When the stratified beds in the boulder clay rest upon the rock, although the rounded or planed outline may be preserved, it is found to possess a much rougher surface than when covered by the unstratified boulder clay. This is seen on the rounded rock by the viaduct before noticed; one side of which is covered by the following beds:—

Soil.	ft.	in.
Boulder clay, with striated stones	3	0
Large stones and sand	2	0
Pebbles mixed with sand	1	6
Grey sand		6
Larger pebbles		3
Sharp grey gravel		3

The Silurian rock under these is beautifully hollowed out and rounded, but it is extremely rough to the hand, is very soft, and shows symptoms of decay.

In a limestone quarry, north-west of Ulverstone, in a well-sinking nearer the town, and also, I believe, in the railway-cutting, roughened and curiously-shaped limestones, similar to those near the iron ore, have been met with, lying under stratified gravels, capped with boulder clay. In the quarry instance, I imagine the upper bed has been much broken up, antecedently to the moulding and roughening of the fragments. They are imbedded in a soft plastic clay; clearly, I think, a deposit from water.

But there is another, and perhaps more difficult problem connected with the boulder clay, which is, when loose gravels and sand, in no respect differing from that deposit in lithological character, lie next the surface-soil.

This is the case on Gill Brow: a moraine bank, a mile to the south-east of Lindale moor, at about 300 feet elevation above the sea.

A mining section there gives:—

Soil.	yds.	ft.
Loose gravel and sand		5
Hard boulder clay to rock	9	0

The stones in the loose strata of gravel and sand are some of them well striated. The thickness of deposits on the top of the hill, is much greater than below.

This bank, and another contiguous to it, appear to be extensions of moraine matter from the higher grounds of Lindale Moor, High Banks, Carr Kettle and Walthwaite Moors, and lie immediately between these and the Plain of Swarthmoor, which is one large spread of boulder clay. Gill Brow would moreover, in all probability, form a side bank on the great ice-flood line of the Pennington Beck, although now situated nearly a mile from the stream. The loose gravel stratum therefore might be part of the delta of that flood. No other suggestion presents itself to my mind. The striations would forbid the gravels being regarded as marine.

In the section formed by the railway-cutting, now grown over, the stratified beds were observed "running in very thin seams" through the boulder clay. They seem to be a constant and familiar accompaniment to that deposit, in the Carboniferous and Silurian grounds of Furness. With the boulder clay on the Permian, I am not yet so well acquainted. Its most southern inland extension, I believe, is at Harbarrow, three and a half miles from the south point of Furness; not far from here, it probably declines down under the red marl of Leece. In piercing through that deposit, near the Leece Tarn, for water, it was supposed to be the boulder clay that was reached at the depth of 112 feet.

Stratified Marine Drift.—It does not appear that the stratified marine drift of Furness can be said to attain in any thickness, to elevations much above 100 feet. Travelled and unstriated boulders, some of great size, water-rolled stones foreign to the district, and stray fragments of shells, are certainly met with; the latter even up to 500 feet, but no undisturbed truly marine deposits exist at such elevations to my knowledge. Several large stones, quite foreign to the district, occur upon and in the boulder clay of Lindale and the neighbouring moors; whether they may be regarded as the remnants of out-swept marine drift, and as marking the base of renewed glaciation, it is difficult to say. Many of them, notwithstanding their hardness, have all the appearance of glacial friction, being much smoothed down and flattened.

Probably they are marine deposits, which we find lying above a mile in shore, at the Ulverstone Railway Station, and extending up the Pennington Vale, to a little above 100 feet; but I believe these are met by, and to some degree commingled, and interstratified with old fluviatile deposits.

In sinking a well some years ago on the south of the town, between the one hundred and the seventy-five contours, a bar of small bivalve shells* was discovered, 8 feet below the surface, in a deposit of fine sand. I have not yet found any on this horizon in other localities, but it may be worth while prosecuting the search further. Passing southward marine drift appears to line the shore at about the same elevation from Ulverstone through the grounds of Conishead Priory to Bardsea. Here they are cut off, and we do not recognize them again till we get below Leece, where they are found sweeping over the promontory from east to west in elongated ridges, one or two of which, by the gradual inroads of the sea, have come to form headlands on the southern shore.

Coast-line Deposits.—One of these headlands, Rabbit Hill, at Barrow in Furness, saved from the sea by railway constructions, is now rapidly undergoing demolition to form levelled sites for streets, and its long entombed granite boulders thrown out to the light of day. On the south coast of Furness, at Back-House-Close Point,† 25 feet raised beaches, containing layers of existing British shells, and abutting against the headland, have in the recollection of persons now living been cut away by the sea. It is the same at Cunninger Point, while in what may have been, so to speak, the recesses of the coast, some still remain; only in their turn to yield eventually to the constant wasting of high tides. Traces of their broken lines occur all the way from Rampside to Aldingham, where they begin to recline on the boulder clay. The former tide-floor presented by this deposit appears to have supplied a clayeyness to the shell and pebble matrix, which renders their extraction, at this particular spot, extremely difficult, the mass being nearly as hard as the boulder clay itself.

For the naming of the shells, I am wholly indebted to the kindness of my friend Miss Gifford, of Minshead, Somerset:—

SHELL LIST.

Murex erinaceus.
Buccinum undatum.
Buccinum reticulatum.
Purpura lapillus.
Turritella terebra.
Turbo (Litorina) litorea.
Turbo (Litorina) neritoides.
Turbo (Litorina) rudis.
Ostrea edulis.
Ostrea (Pecten) varians.
Mytillus edulis.
Gardium edule.
Mactra solida.
Tellina solidula.

Turbo (Litorina) rudis was most abundantly found in the hard shell-beds at Aldingham. Of this species, Mr. Woodward remarks, that it frequents a higher region than *T. litorea*, where it is scarcely reached by the tide. *Murex erinaceus* was only found in these beds, and rare.

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* From the description, I judge they might be Tellina.

† Some of the stones in this cliff are striated, leading to the supposition that it might prove to be an outstanding ridge of the boulder clay resting on Permian strata. As I did not discover the fact of their striation on the spot, it must be left undetermined for the present. Stratified beds of sands appeared in the upper part of the cliff, but its face was much obscured by water springs washing the sands down from above.

Proceeding northwards up the coast, the finest sections in Furness of the boulder clay are exhibited in the cliffs or sea-scarps of Moat Hill, Edge Bank, Beanwell Bank, and Tea Wood, with heights ranging from 50 to 90 feet. Large Carboniferous (or mountain) limestone, boulders, and angular blocks seem ready to slide down; while hard detached and fallen masses become separated in time by the dash and spray of the tides, and strew the shore. Some of the fallen blocks measure 20 feet in circumference, and retain deep groovings on their surfaces.

North of Ulverstone, the boulder clay reappears at Hammerside Point, and constitutes a hill of 60 feet altitude, with an unknown depth. After this, it caps the Carboniferous and Silurian rocks of Plumpton and Threadlow; and then retires back and is not seen again on our line of coast.

CORRESPONDENCE.

On the Outer Tegument of a Section of the Genus Trigonia.

Sir,—Permit me to direct the attention of palæontologists to a remarkable feature in a section of the genus Trigonia, which indicates a wider separation of that section from its congeneric allies, and also an unsuspected imperfection in the state of preservation of some of our most common Jurassic testacea. It has long been known that under the name of *Trigonia costata*, some very different forms of that genus have been figured and described by various authors from Jurassic rocks ranging from the Upper Lias to the Kimmeridge Clay, including fossils from Oolitic limestones, sandy rocks, argillaceous limestones, and from soft unctuous clays. Considering that the materials at the disposal of authors have been derived from such a variety of rocks, and of localities, both European and Oriental, and that such numbers of the great group of the Costatæ have been examined and compared by so many authorities, it might have been expected that their natural-history characters had been fully ascertained, and that the little we have still to learn respecting them would have reference only to the separation or union of species, and to a more accurate definition of their stratigraphical range. I was therefore recently much surprised upon applying my pocket lens to the surface of a fine example of *T. Calypso*, D'Orb., to find that it exhibited a beautifully ornamented surface, consisting of lines of minute granules arranged vertically, and in every respect agreeing with the outer tegument of Gresslya, Anatina, Goniomya, and Myacites, amongst the Myadæ or Anatinidæ. Of this latter family the fossil forms with granulated surfaces may be separated into two divisions, the one having large and widely separated lines of granules, the other with the granules also linear, but very minute, and the rows closely arranged; *Trigonia Calypso*, from the Scarborough Cornbrash, has this latter kind of ornamentation easily overlooked, and preserved only under the most favourable circumstances. Other Trigoniæ with surfaces precisely similar are *T. elongata*, Sow., from the Cornbrash of the same locality, and from the Oxford Clay of Dorsetshire; *T. costata*, var. *lineolata*, Ag., from the grey limestone of Scarborough; another lunulate and lengthened form from the Upper Trigonia grit, Inferior Oolite near Stroud; *T. monilifera*, Ag., from the Coral Rag of Weymouth; and *T. marginata*, Lyc., from the Kimmeridge Clay of Wiltshire. This granulated surface occurring, as is now ascertained, in so many species of the costated Trigoniæ, whose general forms and other characters are very dissimilar, renders it evident that the whole group of the Costatæ is characterized by its presence, although we may only expect to discover it occasionally in specimens derived from fine argillaceous deposits, and cleared simply by washing, or by using only a light brush. The other sections of Trigonia having tubercles, varices, or serrated ribs upon the sides, appear to have been destitute of this granulated tegument, as are also the recent Trigoniæ. I would also venture to remark that the value of the granulated tegument as a ground of distinction in the groups of testacea, does not appear to be sufficiently appreciated by some palæontologists; that it is of higher value to us than as a separation between species, may be inferred from the fact that in the great family of the fossil Anatinidæ it characterizes all the species of the genera in which it occurs, and that the present appears to be the first known instance in which a well-defined genus can be separated into two sections, the one having the surface granulated, the other smooth: in Trigonia, however, it is found to pervade only a single but large and well-defined group, which in its general characters is as clearly separated from the other fossil groups as from the recent members of the genus.

JOHN LYCETT, M.D.

Scarborough, May 4th, 1864.

On the Nebular Theory.

Salford, May 17, 1864.

Sir,—In No. 75 of your 'Geologist,' I find an article on Planetary Orbits, etc., written with a considerable degree of ingenuity, in which you ask, and I suppose with no objection to a reply, for instances "of the evolution of light and heat by *slow* condensation of gaseous matter." Chemistry supplies us with abundance of proof in this respect. One of the most familiar is shale loaded with iron pyrites, which, when exposed to the influence of the atmosphere, often takes fire from the slow absorption of gaseous matter.

So, on the other hand, excessive heat has greater power than chemical affinity, and will, if supplied in sufficient intensity, release the condensed oxygen again from its compound. Metals, too, have a very great power to condense gaseous matter within their pores, and this power is generally proportionate to their spongy and divided character; but if heated, their affinity for gaseous bodies is likewise proportionately increased. But as I have just stated, heat has a greater power than chemical affinity, and therefore no condensation of gaseous matter could take place until it was sufficiently cooled to be within the range of chemical power.

Now the nebular theory assumes that condensation is the result of slow cooling, and could not have taken place in any other manner; consequently, no universal conflagration and condensation could simultaneously have taken place, as your reasoning supposes. Again, if we closely examine the crust of the earth, especially amongst the igneous rocks, with which we only profess now to deal, we shall find that they are combinations of the most infusible character, and, *à priori*, bodies which would be the first condensed, especially when their strong affinities are taken into consideration. And those bodies which are easily dissipated by heat are almost wholly excluded, such as water, carbonic acid, etc.

There is another argument I wish to point out, which I think is erroneous. You suppose that the heat of the earth is sufficiently accounted for on the grounds of its retardation through the ether of space. A little reflection will show that a body once heated to its maximum temperature, from whatever cause, whether in passing through air or the ether of space, if the medium be uniform in resistance and the motion constant, the heated body must necessarily diminish in temperature until it is reduced to the same degree of heat as the medium through which it passes. The reasons are obvious. The original cause of heat in the case supposed is ethereal resistance, and the moving body eliminating heat is in consequence of the rearrangement of its constituent particles adjusting themselves to their altered condition; and when this is attained the heated body must sink again to its normal condition of heat, and could not, I think, permanently retain a heat so much superior to the medium through which it moves, simply in consequence of resistance.

I am, Sir, most respectfully yours,
THOS. GALLASPIE.

[I am very glad to have my suggestions—I do not call them "views"—more fully discussed. Mr. Gallaspie however does not give any of the illustrations, with which he says chemistry abounds, of the *permanent* or rather long-continued production of light and heat by the slow condensation of *gaseous* bodies. Take oxygen and hydrogen. They combine with explosion. The heat, I conceive, which drove these particles apart whilst they were gases, has passed off into the air, and become motion acting upon the particles of the atmosphere. The resulting produce is a drop of water, not boiling. Shales and metals are solid substances; and even if we take metallic vapour, what should cause metallic vapour to exist in space? Where is the heat to come from anywhere except within the circuit of our earth's orbit, which should raise gold, iron, or even tin and lead into vapour. There seems to me not a particle of scientific evidence nor of probability in favour of the nebular *hypothesis*—such it was first properly termed, such it still, to my mind, remains.

The other point as to the effect of the resistance of the ether of space—although I do not agree with Mr. Gallaspie—is better put. The point raised by me was this: if the earth's motion in her orbit be due to any original impetus given to our planet, then the resistance of the ether of space to the earth's motion must give rise to friction, and this friction must be, by the laws of the correlation of the physical forces, be changed into some other force than motion. What is lost by friction as motion must become heat, light, electricity, chemical, or molecular action. As to what is the temperature of space, we have yet to learn what that temperature is in the area of the earth's orbit. Mr. Gallaspie should bear in mind that if this heat of our portion of space be due to the heat of the sun, it can be estimated. But certainly friction may raise a body, gaseous or solid, to, and maintain it at a higher temperature than the surrounding air or gaseous medium. The production of fire by a lucifer match, or the rubbing of two sticks together, shows this. If the heat produced by friction cannot be carried off by the conductivity of the atmosphere, it will be accumulated in the object. As the orbital speed of the earth is, on the spiral-orbit hypothesis, slowly and constantly diminishing, there should be thus consequently a slow and constant diminution of the heat acquired by the past accumulation from higher friction—that is practically a slight cooling of the globe throughout past ages, and at present going on. The amount of this would be negatived, outbalanced, or controlled by the inward tendency of the earth to nearer proximity to the sun. I regret much that space does not permit me to say more in this place.—S. J. MACKIE. *27th May*, 1864.]

COLONIAL GEOLOGY.

LEAVES FROM MY AUSTRALIAN NOTEBOOK.

BY THOMAS HARRISON, OF MELBOURNE.

NO. II.—THE EOCENE BEDS OF SCHNAPPER POINT.

To my mind, the very prettiest of Victorian watering-places is that known as above. It is so, not from brick-and-mortar embellishments, but because still left as made by nature. Nothing can be more striking than the contrast which this quietest of all quiet spots presents to the hurry and bustle incidental to the Victorian metropolis. Reaching the pier, a quaint-looking structure admirably matching the scenery around, one seems to have actually gone backwards twenty or thirty years in Australian history, and to be gazing on a scene such as Melbourne itself may have presented ere gold discoveries had revolutionized the colonies.

Even when regarded from the steamer, miles away, the view is especially prepossessing. Not distinguished by any very grand features; the hills swelling into gentle heights, thickly timbered and dotted at intervals with villa residences peeping from out lawn-like clearings; the cliffs of diverse colours, as formed by the wearing away of granitic or sandstone tongues of land; and the numerous little coves and miniature inlets, of which the doubling every fresh headland gives some novel view, form a bit of scenery half-countrified, half-maritime, as especially pleasing to the Australian, as are Herne Bay, Margate, or the Isle of Wight, to the London cockney.

Geologically, the district to be noticed forms a sort of irregularly-shaped basin, bounded on the north and south by the granitic masses of Mounts Martha and Eliza, on the east by a considerable patch of Silurian rocks, and on the west by the land-locked bay of Port Phillip; the whole having been filled up with Tertiary strata, of which the surface-rock is probably of the Pliocene period.

Two miles northerly from the pier, and at the foot of a spur running from Mount Eliza, a small bed of Carboniferous shales are plainly visible at low water. These contain fragments of plants peculiar to the Victorian Carboniferous period, which appears to have been not earlier than the Oolitic era. The situation of this small outlier gives the beds some little interest. Most of the Victorian coal-bearing rocks occupy a district forming a broad stripe some thirty miles wide, and extending from near Cape Otway to Gipps Land. Carboniferous strata crop out extensively around Geelong, and are known to exist, as underlying beds, over the whole peninsula of Bellarine (a district marked on the map by diagonal lines alternately dotted and black, and sloping towards the right); whilst the same strata, commencing on the eastern shores of Western Port, form the coal district of Cape Patterson, and run, with but few breaks, under the principal part of South Gipps Land. The question, therefore, naturally arises, as to whether the strata of Schnapper Point and Bellarine were not once continuous? If so, unless formed by denuding agencies, Port Phillip Bay must be the result of a fault of depression, caused, it may be, by the chasm left on the vomitting forth of vast quantities of basalt over the whole of south-western Victoria during the Tertiary period.

As bearing in some degree upon this subject, the sinking of the district, I may notice that the aborigines speak of a time when the river Yarra (the mouth of which is some fifteen miles north of the line forming the upper margin of the map), once ran on uninterruptedly to Bass Straits, the intervening portion of country being then dry ground. Such tradition of a depression having taken place during the human period scarcely accords with the observed facts of the land being still in process of elevation, and of the lower spots near Melbourne having been, until very lately, the bottom of estuaries. Peradventure, the story may be referred to another source. The entrance to the bay is exceedingly narrow, not much over two miles in width. The rocks on both sides are identical, and were probably at one time continuous. If this continuity existed for any lengthened period after the adjacent shores had arisen above high-water mark, it is evident the waters of the ocean would be shut out completely, and what is now the Bay of Port Phillip must have existed as a huge salt lake. No large rivers debouching into this, and numerous shoals existing in every portion, it is easy to conceive that the waters would grow gradually shallow, and that many spots would become dry land; the whole forming a large swamp, through the centre of which a chain of lakes might have stretched themselves to what is now the channel running between Points Nepean and Lonsdale, satisfying nearly every requirement of the aboriginal legend. The barrier separating the two waters might, in time, be broken through by waves and tempests. This done, the rush of tide during its flux and efflux would speedily form a channel; and the area, after having existed as a hunting-ground for the savage aboriginal inhabitants, would be transformed into a commodious harbour, sheltering the ships of a great and civilized nation.

The cliffs, and most part of the surface-rock of the Schnapper Point district, are of a somewhat modern Tertiary grit, identical with that found near Brighton; very ferruginous, occupied in many places by patches of lignite, but for the most part not highly fossiliferous, although in certain localities numerous conglomerated shell-beds are by no means of rare occurrence. To the wearing away of these upper Tertiary rocks into a precipitous coast-line, the watering-place owes its reputation for picturesque scenery; although, from their wide extent, and from the fact that the lower beds are covered up, the country immediately inland is rendered singularly uninteresting to a geologist.

At two spots, however, respectively two miles north and south of Schnapper Point Pier (one of them being closely adjacent to the Carboniferous beds previously alluded to), is a considerable outcrop of a much older stratum, generally pronounced to be Eocene, and contemporaneous with that upon which is erected the European capitals of London, Paris, and Vienna.

The southern of these outcrops is very prettily situated. For nearly two miles the upper and red cliff runs parallel with the coast, at a distance of some 200 or 300 yards inland; on the coast itself a second cliff is noticed, worn into the most fantastic forms, and between the two is an intervening valley, resembling in some slight degree, at certain points, the famous Undercliff of the Isle of Wight. The real or fancied similitude to the above well-known spot has, perhaps, induced many persons to refer the valley at Schnapper Point to the same origin as that giving rise to the features incidental to the southern coast of the "beautiful island." A very slight examination will show that this local theory is an erroneous one. The upper or ferruginous strata are comparatively friable and easily denuded, whilst the lower and Eocene beds are either compact argillaceous limestone, or clay of great tenacity. The coast rising—as the whole coast has certainly done—the upper beds would be eaten away more readily than the lower;

and whilst the lower thus stood out as a sort of terrace, some portions of the upper strata would be left undenuded thereupon, the old wave-washed rocks of a former period; hence the second cliff and its fantastic and highly picturesque configuration. This theory is strikingly borne out by the fact that, wherever these Eocene beds appear, there the terrace appears also, prominently noticeable, as is the outcrop of the gault from beneath the chalk all round the valley of the Weald of Kent, Surrey, and Sussex in England.

The beds referred to are evidently of considerable depth, although, from being situate but very little above the water-line, their extent downwards cannot easily be arrived at. The upper portion, for several yards in thickness, is composed of clay, seeming to have been re-deposited, and in which few, if any, fossils are met with. Immediately below this stratum is a great thickness of blue clay, in some places hardened into the compact argillaceous limestone before mentioned. Both as clay and as stone this bed is literally crowded with fossils, in a state of preservation quite startling to the stranger. Many of the shells retain their pristine colour, and look equally bright and perfect with those of the still living mollusca thrown upon the beach. Were it not for their strange and ancient shapes, it would be no easy matter to distinguish between these relics of an immensely distant age and shells of the present day. In state of keeping, the marine exuvial Eocene beds are infinitely better preserved than those which, found in the raised estuary deposits near Melbourne, are regarded as scarcely, if at all, anterior to the human period.

My own experience in searching for organisms among these Eocene strata, reminded me somewhat of a discovery made by the "Uncommercial Traveller,"—to wit, that "when at night one drunken man unaccountably turned up, another drunken man assuredly turned up soon after to keep the first company." What I noted being, that whenever I dropped upon a fine large specimen, I, without exception, dug up another or two close beside it. Not by any means, I should imagine, the result of chance, but that the shells rolling along an uneven sea-bottom would naturally fall into holes and hollows, and just as naturally be washed from off any elevated positions.

Nautili, cypridæ, conidæ, volutidæ, dentalia, cerithidæ, siliquariæ, muricidæ, and bryozoa, are very common, scarcely a square yard of ground being free from some of them, either perfect or in fragments. Among the cypridæ is that singular form *Cypræa eximia*, and others of gigantic dimensions.

The great quantity of tropical species, few, if any, of which are now discoverable in Victorian waters, suggest a variation of climate since the Eocene period in this part of the world, analogous to that remarked in the northern hemisphere. Nor is the great quantity of molluscous and echinodermatous, together with an almost total absence of crustacean and vertebral remains, less worthy of remark. Although the amount of life, according to the former types, must have been prodigiously developed during the period, but very few traces of any superior marine animals are discernible. In two hours, and within a space of barely twenty square yards, I dug out with a common spade from fifty to a hundred distinct species of shells, echinidæ, and corals; yet neither on the above nor any subsequent occasion have I there met with either crustacean or vertebrated remains. The absence of the latter is the more remarkable, seeing that the Cestracion, common enough in Australian waters, especially feeds upon shelly mollusca, and might therefore be expected to frequent a place whereat such particular food happened to be abundant.

A Victorian geologist (M. Blandowski), in a paper read before the Royal Society of Victoria, explains the absence of the above-named sub-kingdoms, by suggesting that the higher development and superior locomotive powers possessed by their various members, allowed of escape during the deposition of that muddy sediment completely enveloping the more sluggishly moving of their contemporaries. Such an hypothesis would of course involve a supposition of the muddy sediment having been suddenly deposited; a circumstance hardly reconcilable with the fact that the beds, where fossiliferous, appear to contain shells pretty equally distributed throughout a considerable thickness, and are not, as would result from a sudden deposition like that supposed, made up of a thick layer of unfossiliferous clay reposing upon a stratum of shells and organisms. Among the fossils, too, which I have by me, is a pecten, having an incrustation of bryozoa upon its inner surface—proof positive. I imagine that the shell must, after the death of its inmate, have lain during some time uncovered, or the growth of such parasite, in such position, could not possibly have taken place. And again, although every shell appears perfect and unworn by friction, yet in all conchifers and brachiopods the valves are disunited, and in univalves the operculum is invariably absent. If it is allowable to strain a point, I would suggest that previous convulsive movements had totally destroyed or greatly diminished the number of all the superior marine tribes in these waters; and that the lower classes, escaping the catastrophes by virtue of their less sensitive organizations, and subsequently multiplying greatly, simply that their enemies had been destroyed, had grown to be more than ordinarily numerous.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society.—*March* 9.—W. J. Hamilton, Esq., President, in the chair.

1. "On the Discovery of the Scales of Pteraspis, with some Remarks on the Cephalic Shield of that Fish." By Mr. E. Ray Lankester. The successive steps by which the genus Pteraspis came to be established, and the grounds on which the prevalent opinion as to its ichthyic nature rests, having been noticed, the author proceeded to describe in detail the scales,—which have lately been discovered at Cradley, near Malvern, and which alone were required to remove all doubt as to the affinities of the genus,—comparing them with those of Cephalaspis, to some of which they bear a great resemblance; and he concluded by giving a description of the markings on the surface of the cephalic shield of *Pteraspis rostratus*.

2. "On some Remains of Bothriolepis from the Upper Devonian Sandstones of Elgin." By Mr. G. E. Roberts. Remains of a large Dendrodoid Cælacanth obtained by the author in Elgin were referred by him to the genus Bothriolepis. These consisted of two large casts of a central head-plate, with portions of the test; a natural cast considered by him to represent the parietal, squamosal, scapular, and coracoid bones; casts of the nasal bones, and teeth of the upper jaw; together with tooth-like bodies, which were suggested to be teeth, originally situated in the posterior region of the mouth. The ornament borne upon the head-plate was next described by the author; and, in conclusion, the affinities between

the genera Bothriolepis, Asterolepis, Pteraspis, and Cephalaspis were discussed.

3. "On Missing Sedimentary Formations from Suspension or Removal of Deposits,—their general relations and importance." By Dr. J. J. Bigsby. In this paper the author brought together nearly all the known instances of gaps or blanks in the stratigraphical succession in different countries. Of the two formations which are in apposition through the absence of one or more formations, which thus constitutes a blank, Dr. Bigsby applied the term "Roof" to the upper, and "Floor" to the lower. He then described briefly the principal instances, arranging them according to the age of the formation constituting the "Roof," and drawing certain inferences from a consideration of them respecting the influence of oscillation of level, emergence, denudation, etc., in their production. In his concluding observations Dr. Bigsby observed that these gaps indicate that there always have been areas of dry land, and also showed that they prove the geological record to be, in places very much obscured, if not entirely obliterated.

Geological Society.—*March* 23.—1. "On some new Fossils from the Lingula-flags of Wales." By Mr. J. W. Salter.—Since the author's paper last session on the discovery of *Paradoxides* in Britain, the researches of Mr. Hicks have brought to light so many new members of the hitherto scanty fauna of the Primordial zone, that Mr. Salter was now enabled to describe two new genera of Trilobites, and a new genus of Sponge, and to complete the description of *Paradoxides Davidis.* He also remarked that the fauna of the Lingula-flags shows an approximation, in some of its genera, to Lower Silurian forms, and some—the shells and a cystidean—are of genera common to both formations; but the crustacea, which are the surest indices of the age of Palæozoic rocks, are of entirely distinct genera; and their evidence quite outweighs that of the other fossils. The Primordial zone is, moreover, in Britain separated from the Caradoc and Llandeilo beds by the whole of the Tremadoc group, at least 2000 feet thick. 2. "On the Millstone-grit of North Staffordshire, and the adjoining parts of Derbyshire, Cheshire, and Lancashire." By Mr. E. Hull and Mr. A. H. Green.—In this paper the Millstone-grit series was described, from the eastern edge of the Lancashire coal-field southwards to the coal-fields of North Staffordshire. After giving a general sketch of the geology of the district, and defining the upper and lower limits of the Millstone-grit, the authors explained a series of sections, running from east to west, at intervals across the country. In the most northerly of these the group consists of five thick gritstone-beds, separated by seams of shale, and attains a thickness of more than 2000 feet; while on the extreme south all but two of these beds have thinned away, and the whole thickness is there not more than 300 or 400 feet.

Between the base of the Millstone-grit and the Carboniferous limestone lies a group of shales and sandstones, with thin earthy limestones towards the bottom, which seem to hold the place of the Yoredale Rocks of Yorkshire. The mineral character of these beds was described, and their place noted on the sections.

A short notice was also given of two small in-liers of Carboniferous limestone, namely, at Moxon, east of Leek, and at Astbury, near Congleton.

Geological Society.—*April* 27.—1. "On the Geology of Arisaig, Nova Scotia." By the Rev. D. Honeyman.—A careful examination of the country in the neighbourhood of Arisaig enabled the author to construct three sections and a map, showing the geological constitution of the district. Two of these sections were nearly parallel to one another, running from north to south, and taken some distance apart, while the third was nearly at right angles to the other two; thus a tolerably accurate idea of the geology of the country could be obtained. The author described each of these sections in detail, giving lists of the fossils found in the different beds, which proved them to be of Upper Silurian age; and he further considered that they justified the adoption for the subdivisions of these Nova-Scotian Silurians of the terms May-hill, Lower Ludlow, Aymestry, and Tilestones, the first and third of which had been used for them previously by Mr. Salter. Besides Silurian rocks, there occurs in the western part of this district a conglomerate of Lower Carboniferous age, while trap-rocks occur on the north and south.

2. "On some Remains of Fish from the 'Upper Limestone' of the Permian Series of Durham." By Mr. J. W. Kirkby.—The object of this paper was to record the discovery of fish-remains in the upper magnesian limestone of the Permian formation, which is higher in that series than any vertebrate remains had been previously known to occur. The strata exposed in the quarries were described in detail, especially the bed from which most of the fish were obtained, and which is known as the "flexible limestone."

The author stated that at least nine-tenths of the specimens belong to *Palæoniscus varians*, the remainder belonging to two or three species of the same genus, and to a species of *Acrolepis*. Detailed descriptions of the different species of fish were given, as also were short notices of the species of plants sometimes found associated with them, one of which he believed to be *Calamites arenaceus*, a Triassic species. The occurrence of *Palæonisci* with smooth scales was stated to be antagonistic to Agassiz's conclusion, that the Permian species of that genus have striated, and the Coal-measure species smooth scales. In conclusion, Mr. Kirkby remarked that the fauna of the period appeared to have an Estuarine facies, and he expressed his opinion that the fishes were imbedded suddenly, as a result of some general catastrophe.

3. "On the Fossil Corals of the West Indian Islands. Part 3: Mineral Condition." By P. Martin Duncan, M.B.—The results of the process of fossilization, as seen in the West Indian fossil corals, being very remarkable, and having much obscured their specific characters, thus rendering their determination extremely difficult, Dr. Duncan found it necessary to thoroughly examine their different varieties of mineralization, and to compare their present condition with the different stages in the decay and fossilization of recent corals as now seen in progress. Thus the author was enabled to show the connection between the destruction of the minuter structures of the coral by decomposing membrane and certain forms of fossilization in which those structures are imperfectly preserved; and he likewise stated that the filling-up of the interspaces by granular carbonate of lime and other substances, as well as the induration of certain species, during a "pre-fossil" and "post-mortem" period, gave rise to certain varieties of fossilization, and that the results of those operations were perpetuated in a fossil state.

The forms of mineralization described by Dr. Duncan are—Calcareous; Siliceous; Siliceous and Crystalline; Siliceous and Destructive; Siliceous

Casts; Calcareo-siliceous; Calcareo-siliceous and Destructive; Calcareo-siliceous Casts.

In describing these forms especial reference was made to those in which the structures were more or less destroyed during the replacement (by silica) of the carbonate of lime which filled the interspaces, and during that of the ordinary hard parts of the coral.

In explaining the nature and mode of formation of the large casts of calices from Antigua, the author drew attention to the fact that the silification is more intense on the surface and in the centre of the corallum than in the intermediate region; and, when examined microscopically, it could be seen that the replacement of the carbonate of lime began by the silica appearing as minute points in the centre of the interspaces and of the sclerenchyma, and not on their surface. In conclusion, the relation of hydrated silica to destructive forms of fossilization was discussed, together with the influence of all the forms enumerated above in the preservation of organisms, and as one cause of the incompleteness of the geological record.

May 11.—1. "On a Section with Mammalian Remains near Thame." By Mr. T. Codrington, F.G.S.—A railway-cutting through a hill between Oxford and Thame having exposed a section of certain gravel-beds, from which many mammalian remains were collected, the author now gave a short description of the section, and a list of the bones he had obtained from it. The hill is nearly surrounded by the Thame and two small tributaries, and consists of Kimmeridge clay capped by a bed of coarse gravel overlaid by sandy clay. The gravel consists of chalk-flints, pebbles derived from the Lower Greensand, and fragments of mica-schist, etc., indicating a northern-drift origin; it contained many bones of Elephant, Rhinoceros, Horse, Ox, and Deer, and a single phalanx of a small carnivore, but no flint implements were discovered.

2. "On a Deposit at Stroud containing Flint Implements, Land and Freshwater Shells," etc.* By Mr. E. Witchell, F.G.S.—In the construction of a reservoir near the summit of the hill above the town of Stroud, the author observed, about two feet from the surface, a deposit of tufa containing land-shells, with a few freshwater bivalves; in it he subsequently discovered several flint flakes of a primitive type, and in the overlying earth a few pieces of rude pottery. As the deposit is situated on the spur of a hill nearly separated from the surrounding country by deep valleys, and as Mr. Witchell considered it to be comparatively recent, he concluded that it had been formed in a pond or lake, which had been caused by a landslip from the higher ground producing a dam that stopped the downflow into the valley of the water of the neighbouring springs.

3. "On the White Limestone of Jamaica, and its associated intrusive rocks." By Mr. A. Lennox, F.G.S.—The White Limestone of Jamaica was described as including a basement series of sandstones and shales, a hard white limestone, a yellowish limestone, and an uppermost member consisting of dark-red marl; it was estimated to be at least 2500 feet thick; and the author stated that, at the junction of the calcareous rocks with the granite, the former was often more or less altered, and this appeared to be the best proof of the Tertiary age of the latter. Mr. Lennox then adverted to a diagram-section of the rock-formations of Jamaica by the late Mr. Barrett (Quart. Journ. Geol. Soc. vol. xix. p. 515), which he con-

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* Described already by Mr. John Jones, of Gloucester. See 'Geologist,' Vol. VI. p. 307.—Ed. Geol.

sidered erroneous on the following grounds:—(1) he knows no section in Jamaica in which the relation of the White Limestone to the Hippurite-limestone is seen; (2) the White Limestone he believes to be of Miocene age; and (3) the shaly and sandy beds represented in the section as overlying the White Limestone he considers to be undoubtedly in infra-position. The author then discussed the question of the age of the White Limestone, first on physical grounds, and afterwards palæontologically, inferring that it was decidedly of Miocene date; and in conclusion he remarked that the White Limestone had probably been deposited slowly in a tranquil sea, and discussed its relation to the Tertiary beds of the other West Indian Islands.

4. "Facts and Observations connected with the Earthquake which occurred in England on the morning of the 6th of October, 1863." By Fort-Major T. Austin, F.G.S.—Earthquakes in the British Isles attract usually but little notice, owing probably to the mild form in which they generally occur; but that one treated of in this paper, owing to its greater violence, aroused attention to the subject. The disturbance was said to extend from a point in St. George's Channel forty or fifty miles to the north-west of Pembrokeshire to Yorkshire, and the focus of the disturbance to be situated near the former spot. The author brought forward a number of facts for the purpose of proving the intensity of the shock, the time at which it occurred, the number of vibrations, their direction (which was considered to be from W.N.W. to E.S.E.), and the occurrence of incidental phenomena, and concluded by passing in review the natural causes competent to produce these and other characteristics of earthquakes.

NOTES AND QUERIES.

The Measurement of Heights by the Aneroid.—The following explanation of the use of the aneroid in taking heights is given by Mr. Spencer Browning, of the Minories, in a pamphlet published by him. His aneroids, especially his mountain- and small pocket-instruments, are unequalled for finish and accuracy.

The *theory* on which the measurement of heights is effected by the barometer, the aneroid, or the sympiesometer, is exceedingly simple, though the *application* of the theory depends on formulæ which have required mathematical skill to construct, and which include "constants" obtained by delicate experiment.

Theory.— Let m and m' be two stations on a mountain side: required to find the difference of elevation between them.

The aneroid (or barometer or sympiesometer) having been corrected for the effect of temperature upon *its own mechanism,* shows at m the weight of a column of air, having the vacuum box of the instrument for its base, and reaching from m to the extreme limits of the atmosphere. Similarly, an observation at m' gives the weight of the upper portion of an identical column of air, reaching from m' to the limits of the atmosphere.

Consequently the excess of pressure at m above that at m' gives the weight of that part of the column which extends from the level of m to the level of m'.

Knowing the weight of the column, if we also ascertain the specific gravity of the air that composes it, we have data for calculating its *height.*

To learn the specific gravity of the column, two main influences have to be taken into account. There are also secondary ones, of so little importance that we shall not notice them here.

(A) The specific gravity of the air, other circumstances being the same, bears a definite ratio to the pressure it sustains; that is, the greater the pressure, the more it is condensed and the more does a cubic foot of such condensed air weigh. The lower strata of the atmosphere are therefore denser than the higher.

(B) The specific gravity of the air, other circumstances being the same, is greater in proportion to its coldness. Air that is cold weighs more than air that is hot.

Formula.—These principles are simple enough. Experiments made with extraordinary care have shown the *amount* of the above influences, and the *laws* by which they act. Mathematicians, and notably La Place, have thrown the whole into a formula conveniently adapted for computation. It is substantially as follows, in which the letters A and B refer to the paragraphs (A) and (B), and S represents the secondary considerations, from which we abstain:—

$$\text{The height of } m' \text{ above } m = (A_{m'} - A_m) \times \{1 + B + S\}.$$

The calculation of the weight of a column of air, reaching to the limits of the atmosphere, on the principle (A), for all pressures of the barometer, at intervals of $\frac{1}{100}$th of an inch, has been made, and forms, in some modified shape, the *first* of the usual barometric tables.

Browning's new aneroids, besides being graduated to inches of barometric pressure, are also graduated according to the length of the column, determined on the principle (A); the starting-point having been so taken, that when the barometric pressure is 30 inches, the graduation marks 0 feet. The graduation is always made on the assumption of the temperature of the air being 32° Fahr. A_m is the graduation that would be indicated, under that hypothesis, at the station m, and $A_{m'}$ that at m'.

To correct these results on the principle (B), the temperature of the air is observed at m and again at m'. The mean of the two temperatures gives at least an approximation to the mean temperature of the entire column of air. The excess of this mean temperature above 32°, divided by 450 (one of the constants that have been determined by experiment), forms B.

In other words, if t be the temperature at m, and t' at m',

$$B = \frac{(t - 32^\circ) + (t' - 32^\circ)}{2} \times \frac{1}{450} = \frac{t + t' - 64^\circ}{900}.$$

Hence the first and the important part of La Place's formula is—

$$(A_{m'} - A_m) \times \left\{1 + \frac{t + t' - 64}{900}\right\}.$$

Example I.—Suppose a single traveller to wish to take the height of a mountain, m', above the valley, m. He observes at m, before starting, that his aneroid points, say to 450 feet, and his thermometer to 50° Fahr. On reaching the top of the mountain m', he finds his aneroid to give 9560 feet, and his thermometer to be 40° Fahr.

$$\begin{array}{rl} \text{then } A_{m'} &= 9560 \\ A_m &= \underline{450} \\ A_{m'} - A_m &= 9110 \\ & \;\underline{260} \\ \left.\begin{array}{r}\text{True height of} \\ m' \text{ above } m.\end{array}\right\} & \;9370 \end{array}$$

$$\begin{array}{rl} t &= 50 \\ t' &= 40 \\ \hline t + t' &= 90, \text{ and } \dfrac{t + t' - 64}{900} = \dfrac{26}{900} \end{array}$$

$$9110 \times \frac{26}{900} = 260$$

If there were two observers, they would of course work simultaneously, one in the valley and the other on the hilltop, to guard against such material change of temperature or pressure as might take place while a single traveller was climbing.

Example II.—If the traveller desire to know his elevation above the sea and has no simultaneous observations to refer to, he must *assume* the pressure at the sea-level to be at its average, viz. 30 inches, and make the best guess he can at what would be the temperature of the air; the temperature decreasing, on a rough average, 1° for each 300 feet elevation. Let us suppose it in the above case to be 52°; then the height of M_1 above the sea is thus worked out:—

$$\begin{array}{r} t=52 \\ t'=40 \\ \hline t+t'=92 \end{array} \text{ and } \frac{t+t'-64}{900}=\frac{28}{900}$$

$$\begin{array}{rr} A_m-0= & 9560 \\ & 308 \\ \cline{2-2} \text{Height of } M_1 \text{ above sea} \Big\} & 9868 \end{array} \quad 9560\times\frac{28}{900}=11\times28 \text{ about } =308$$

The following tables refer to S, and explain themselves. They are the only ones that have to be applied to an aneroid or to a sympiesometer:—

TABLE I.

Correction for the difference of gravity in various latitudes. Correction positive from lat. 0° to 45°, negative from 45° to 90°.

Approximate difference of level.	Latitudes.				
	0° 90	10° 80	20° 70	30° 60	40° 50
1,000...	3	2	2	1	1
5,000...	13	12	10	7	2
10,000...	26	24	20	13	5
15,000...	39	37	30	20	7
20,000...	52	49	40	26	9

TABLE II.

Table for decrease of gravity in a vertical, acting on the density of the air—always *additive*.

Approximate difference of level.	Height of Aneroid at Lower Station.			
	inches. 16	inches. 20	inches. 24	inches. 28
	feet. 16,000	feet. 10,000	feet. 6,000	feet. 2,000
	feet.	feet.	feet.	feet.
1,000...	2	1	1	0
5,000...	8	5	3	1
10,000...	16	10	6	2
15,000...	24	15	8	3
20,000...	31	20	11	3

The aneroid may be briefly described as follows:—

The weight of a column of air, which in the ordinary barometer acts on the mercury, presses in the aneroid on a small round German-silver box, both surfaces of which are corrugated in concentric circles, to improve the elasticity of the metal. The indications are thus obtained without the use of mercury or any other fluid.

The new aneroid, which has been so favourably received and extensively patronized by members of the Alpine Club, is the result of a series of experiments carried on continuously for several years. The first point accomplished was the perfect compensation of the instrument for temperature. This was effected by introducing a compound bar of steel and brass to form one of the levers which transmits the movements of the vacuum chamber to the hand. For this important improvement a prize-medal was awarded to Spencer, Browning, and Co., in 1862.

Mr. Browning's aneroids possess the following advantages :—

1st. They are most carefully corrected for temperature, from about 30° to 100° Fahrenheit, by compound bars of metal, on the principle of the chronometer balance-wheel.

2nd. They are divided by actual comparison with a Kew *verified* gauge, every inch varying in length : other makers mark an equal scale on the dial, and endeavour to regulate the works so that the movement shall correspond. Any scientific person will soon see that this is a mechanical impossibility.

3rd. They have vacuum boxes made of fine hard-tempered gold, which impart the property to them of returning closely to their zero after experiencing a change of pressure of 16 inches.

4th. They have the centre pivots jewelled, to diminish friction as far as possible : greater sensitiveness is thus obtained, and from the more accurate fitting of the centre staff, the instrument is not so liable to change its zero in travelling.

A card, with a table of the index errors of the instrument, is given with each aneroid ; or the instrument will be sent to Kew for verification upon payment of 5*s*., if a fortnight's time can be given.

When an aneroid has changed its zero, it has been customary to correct it by turning a screw at the back of the instrument, which acts through the medium of the mainspring on the vacuum chamber.

This, however, is attended with two rather serious objections :—1st, it alters the tension of both the mainspring and the vacuum chamber, which do not settle down for some time ; and, 2nd, *it alters the range of the whole instrument.*

These objections can now be obviated by a beautiful but simple contrivance, suggested to Mr. Browning by Francis Galton, Esq., F.R.S. This consists in making the dial turn round on the barometer case. By this arrangement the instrument is readily corrected by turning the dial until the required division comes under the pointer.

These aneroids should be held in a horizontal position while being read, and *not tapped* previous to taking an indication.

TERTIARY MAMMALIA AND SHELLS. — The Tertiary beds of Madrid contain, according to Messrs. Sullivan and O'Reilly, bones of *Anoplotherium Paleotherium, Antelope, Cervus, Sus, Rhinoceros, Hippopotamus, Mastodon.* The Tertiary dolomitic limestone near Guadalaxara is often completely full of the shells of *Limnæa planorbis, Paludina, Helix,* etc.

ERRATA IN FOSSIL BIRDS.—The following corrections in the references to the Plates require to be made :—At page 18, line 12, *for* "see Pl. IV.," *read* see fig. 2, Pl. III. ; line 13, *after* ("fig. 115") *insert* see Pl. IV. fig. 3 ; at page 23, second line from bottom, *for* "Pl. V.," *read* Pl. XII. It will be desirable, throughout the entire series of papers, to refer to the figures in the Plate by the notations given in the Explanation of the Plates at page 233, rather than by those given in the articles, as some errors have occurred.—S. J. M.

ERRATA.—Page 87, last paragraph, *for* "*R. Ungeriana;* and Reuss's *R. ammonoides,*" read "*R. Ungeriana,* and Reuss's *R. ammonoides ;*" it not being intended to liken the last to *R. Akneriana* next mentioned.

	Genera and Species.	Jokély's Divisions.			Localities.	Authorities.
		Lower.	Middle.	Upper.		
	ACOTYLEDONES.					
	Algæ.					
1	Spongilopsis dyadica, *Gein.*	·	·	*	Huttendorf and Oberkalna	Geinitz, Dyas, p. 336.
2	Zonarites digitatus, *Brongn.* sp	·	·	*	Oberkalna	D. Stur.
	Equisetaceæ.					
3	Calamites communis, *Ettg*	·	·	*?	Peklov	D. Stur.
	Asterophyllitæ.					
4	Annularia longifolia, *Brongn*	*	·	·	Podhor	Jokély, 1861, p. 382.
5	A. sphenophylloides, *Zenk*	·	·	*	Kostálov	D. Stur.
6	A. carinata, *v. Gutb.*	·	·	*?	Peklov	D. Stur.
7	Volkmannia gracilis, *Sternbg.*	·	·	*?	Peklov	D. Stur.
8	V. distachya, *Ettg.*	·	·	*?	Peklov	D. Stur.
9	V. polystachya, *Sternbg*	·	·	*	Kostálov	Jokély, p. 382.
	Filices.					
10	Sphenopteris bipinnata, *Mün.?*	*	·	·	Kozinec	D. Stur.
11	Hymenophyllites semialatus, *Gein.*	·	·	*	Kalna	D. Stur.
12	Odontopteris obtusiloba, *Naum.*	·	·	*?	Peklov	D. Stur.
13	Neuropteris tenuifolia, *Sternbg.*	*	·	·	Nedocz and N. von Podhor	Jokély, 1861, p. 382.
14	Cyatheites arborescens, *v. Schl*	*	·	·	Stepanic	Geinitz, Dyas, p. 338.
		·	·	*	Hennersdorf & Huttendorf	,, ,, ,,
		·	*	·	Ottendorf	,, ,, ,,
15	C. Oreopteridis, *Göpp.*	*	·	·	Nedvez and Podhor	Jokély, 1861, p. 382.
				*?	Peklov	D. Stur.
16	C. confertus, *Sternbg.* sp.	·	·	*	Hennersdorf & Huttendorf	Geinitz, Dyas, p. 338.
		·	·	*	Kostálov	D. Stur.
		·	*	·	Ottendorf	Geinitz, Dyas, p. 338.
17	Alethopteris pinnatifida, *v. Gutb.* sp.	*	·	·	Hermannseifen	,, ,, 339.
18	A. Cistii, *Brongn.* sp	·	·	*?	Peklov	D. Stur.
19	A. Gigas, *v. Gutb.* sp	·	·	*?	Peklov	D. Stur.
20	Tæniopteris abnormis, *v. Gutb*	·	·	*	Oberkalna	Geinitz, Dyas, p. 339.
21	Partschia Brongniarti, *Sternbg*	*	·	·	N. von Podhor	Jokély, 1861, p. 339.
22	Psaronius infarctus, *Ung.*	·	*	·	Neu-Paka	Geinitz, Dyas, p. 339.
23	P. helmintholithus, *Cotta*	·	*	·	Neu-Paka	,, ,, ,,
24	P. Zeidleri, *Corda*	·	*	·	Neu Paka	,, ,, ,,
25	P. Haidingeri, *Stenzel*	·	*	·	Neu-Paka	,, ,, ,,
26	P. asterolithus, *Cotta*	·	*	·	Neu-Paka	,, ,, ,,
	Lycopodiaceæ.					
27	Walchia piniformis, *v. Schl.* sp	*	·	·	Stepanic	,, ,, ,,
	(Lycopodites Bronnii, *v. Schl.* sp.).	·	·	*	Oberkalna and Huttendorf.	,, ,, ,,
		*	·	·	Kozinec	D. Stur.
		·	*	·	Ottendorf	Geinitz, Dyas, p. 339.
	MONOCOTYLEDONES.					
	Palmæ.					
28	Guilielmites umbonatus, *Sternb.* sp.	.	.	.	Böhmen	Geinitz, Dyas, p. 340.
	DICOTYLEDONES.					
	Cycadeæ.					
29	Pterophyllum Cottæanum, *v. Gutb.*		.	.	Peklov	D. Stur.
	Nöggerathieæ.					
30	Cordaites Ottonis, *Gein*	*	·	·	Hohenelbe	Geinitz, Dyas, p. 341.
31	Nöggerathia palmæformis, *Göpp*	*	·	·	Stepanic	,, ,, ,,
32	Cyclocarpon	*	·	·	Stepanic	,, ,, ,,
		*	·	·	Waltensdorf	,, ,, ,,
	Coniferæ.					
33	Araucarites cupressus, *Göpp*	*	.	.	Kozinec	Jokély, 1861, p. 393.
34	A. Cordai, *Ung.*	.	.	*	Kostálov	,, ,, 382.
35	A. Schrollianus, *Göpp.*	.				
			*		Pecka	,, ,, 394.
36	A. Agordicus, *Ung.*	.	.	.	Malotic, near Böhm.-Brod.	
	Sigillarieæ.					
37	Sigillaria, sp	.	.	*	Huttendorf	Geinitz, Dyas, p. 343.

CURRENT CLASSIFICATION OF FOSSIL SPONGES.—The following classification, certainly very erroneous, appears to be, as nearly as may be, that which is current amongst British geologists. The Editor would be much obliged by communications as to proposed and necessary amendments.

I. OCELLARIDÆ.

Coscinopora.
Guettardia.
Ventriculites (*Ocellaria*).
Brachiolites.
Cephalites (*Cribrospongia; Tragos*, Goldfuss, non Schweg.).
Cœloptychium.
Retispongia.
Thalamospongia.
Palæospongia.
Porospongia.
Goniospongia.

II. SIPHONIDÆ.

Eudea (*Scyphia*).
Perispongia.
Camerospongia.
Verticillites.
Cnemidium.
Siphonia (*Halirrhoa; Polypothecia*).
Hippalimus (*Scyphia*).
Choanites.
Jerea (according to *Morris*).
Paramoudra.

III. LYMNOREIDÆ.

Lymnorea.
Tremospongia.
Leiospongia.
Actinospongia.
Rhizospongia.
Mammillopora (*Lymnorea*).

IV. SPARSISPONGIDÆ.

Chenendopora (*Manon*).
Forospongia.
Jerea (according to *D'Orbigny*).
Marginospongia.
Pleurospongia.
Hemispongia.
Verrucospongia (=*Manon*).
Sparsispongia (=*Stromatopora*).
Stellispongia.

V. AMORPHOSPONGIDÆ.

Cupulospongia.
Plocoscophia.
Meandrospongia.
Amorphospongia (*Achilleum*).
Turonia.
Strematopora.
Spongia.

VI. HALICHONDRIDÆ.

Cliona (*Vioa; Entobia*).
Halichondria.
Thoosa.
Spongilla.
Alcyonella.
Geodia.
Tethya.
Grantia (*Leucalia*).
Dunstervillia.

VII. CLIONIDÆ.

Cliona.
Talpina.

VIII. UNCERTAIN.

Conis.
Coscinopora.
Steganodictyum.
Udotea.
? Steganodictyum.
Stromatopora.

Intimations from collectors as to the collections they have formed, would also especially oblige.—S. J. M.

COAL-BEDS OF THE NOTTINGHAM COLLIERIES.—*Eastwood Colliery.*—The coal is of excellent quality, free from dust, throwing out great heat; durable and clean in burning, and said to be very superior for general household purposes. *Watnall, Beauvale, and Brinsley Collieries.*—The "Comb Coal," the highest workable seam, is 2 feet 6 inches thick, and is used for household purposes in the midland counties of England. It is a free and bright burning coal, leaving a small quantity of red ashes. *Eastwood and Cotmanhay Collieries.*—The deep soft coal is most extensively worked for household purposes; it is about 180 yards below the "top hard coal," and about four feet thick. The markets for this coal are London and most of the counties south of Derbyshire. It is free burning, leaving a small quantity of brown ashes. The "bottom hard coal" is about 20 yards below the deep soft coal, and is 3 feet 6 inches thick. It is used extensively for locomotive purposes by the London and North-Western, Midland, Great Northern, and other railways in England. It is also used for general steam purposes. In the midland counties it is extensively used for iron-making. Like the top hard coal, it burns without clinker, and will bear exposure to any atmosphere for years without deterioration. It is procured in large blocks. The evaporative power in ordinary working of a locomotive is nearly 7lb. of water for 1lb. of coal consumed. *High Park, Beggarlee, Underwood, Watnall, and Old Brinsley Collieries.*—The "top hard coal," one of the highest workable seams in Derbyshire and Nottinghamshire, is 5 feet thick, and is used extensively for locomotive purposes by the London and North-Western, Midland, and other railways in England. It is also used for steam navigation, and is one of the purest and best iron-making coals. It burns without clinker, and bears exposure to any atmosphere for years without deterioration. It is procured in large blocks without small, and is generally preferred for household purposes in the counties of Lincoln, Rutland, and Leicester. The evaporative power in ordinary working of a locomotive is 7lb. of water for 1lb. of coal consumed.

AN EARTHQUAKE IN SUSSEX.—Shortly before midnight on the 30th of April last, a curious phenomenon was experienced at Maresfield, Sheffield Park, Fletching, Chailey, and the neighbourhood, and which has been attributed to the shock of an earthquake. As may very naturally be supposed, the occurrence created some degree of alarm at the time, and has since formed the subject of general conversation in the part of the county where it was experienced. The shock seems to have been confined to a somewhat limited area, and is fortunately unaccompanied by any serious results. It was, no doubt, generally felt about the same moment, and although the difference of a few minutes has been stated at various places, this circumstance is probably owing more to the variation of the time as recorded by the owners' timepieces than to any actual difference. At Maresfield, the phenomenon was experienced at nine minutes past eleven, and is described in a letter from Captain Noble as an extraordinary vibration lasting fifteen seconds, and shaking the doors, windows, and beds at Maresfield Lodge with some violence. The oscillation and vibration were likewise generally felt throughout the parish. At Sheffield Park, the seat of the Earl of Sheffield, the earthquake was felt by the members of the noble earl's family and household. The time recorded here is six minutes past eleven. Among other indications the butler heard the mortar fall behind the wainscot, and a loose bar attached to a window-shutter oscillated and struck the shutter. Lord Pevensey and Mr. Douglas Holroyd, who were at Sheffield Park, distinctly felt the shock. At Scaymes Hill, it is stated that the bells at the public-house distinctly vibrated; while at Fletching, the family of Mr. Jones were disturbed by a rumbling noise. Similar sensations were experienced at Buckham Hill and at Chailey—more especially at two cottages at the latter place, where the shock seems to have been more severely felt. Writing from Maresfield to the 'West Sussex Gazette,' Captain Noble says:—"It may be worth while to record a curious phenomenon observed at Maresfield last night (April 30th), inasmuch as, after our experience of the 6th October ult., it may very probably be referable to an earthquake. About 11 h. 9 m. G.M.T., an extraordinary vibration was felt here, lasting, as nearly as I can gather, some fifteen seconds, and shaking the doors, windows, and beds in this house with some violence. Most curiously, I felt nothing of it myself, but several of my servants left their beds in alarm. One of the ladies of my family describes the sensation she experienced as that of having her bed moved to and from the wall against which its head stands, as though some one had got underneath it and were trying to lift it. As the bedstead in question stands nearly S.E. and N.W., this may serve to give an idea of the path of the earthquake-wave, if such it were. I learn from various sources that this oscillation and vibration were felt all over the parish. Finally, three of my female servants were again alarmed some time after midnight by a rushing sound, as though of violent hail, passing close to their windows, although, on looking out, nothing was visible, nor has either hail or rain fallen here since the 28th ultimo." [It has been reported that a second shock was felt soon after midnight, but not so forcible as the first.] In the town of Lewes, it appears, the shock was distinctly felt. One lady states that while speaking to her servant in the kitchen, a few minutes after eleven o'clock, she heard a sudden shaking of the front door and windows, the unusual violence of which greatly alarmed the servant girl. Thinking the shaking noise was occasioned by the return of her husband, who had been out upon some business, the servant went to look, and was surprised to find that no one had entered. As the house stands in close proximity to the railway, and is frequently shaken by the motion of passing trains, this violent agitation of the door and windows was at the time attributed to this cause. Shortly after midnight, when this lady had retired to rest, she states that she heard a peculiar and rushing sound, as if of hail or rain being forcibly driven against the windows. Many persons supposed there must have been a serious explosion of gunpowder somewhere, and one gentleman says, "I was sitting reading on the ground-floor at the time, and my chair quite shook under me." The shock does not appear to have been attended with serious consequences of any kind.

THE GEOLOGIST MAGAZINE.—Future communications respecting 'The Geologist' should be addressed to Mr. Mackie, 25, Golden Square. Back numbers and volumes previous to 1862 may be obtained of Mr. Gregory, 25, Golden Square, W. Remittances and applications for Vols. V. VI. and VII. are to be made to the present publishers, Messrs. Reeve and Co. —ED. GEOL.

REVIEWS.

Notes on the Geology and Mineralogy of the Provinces of Spanish Santandar and Madrid. By W. K. Sullivan, Ph.D., and J. P. O'Reilly, C.E. London: Williams and Norgate. 1863.

As very little is generally known of Spanish geology, every contribution that makes us better acquainted with what must be an interesting country is more than usually acceptable. The volume before us is composed of papers originally printed in the 'Atlantis' (vol. iv.), and relates chiefly to minerals and mining-matters. It is, however, abundantly illustrated with maps, views, and sections, and gives a good deal of information of the stratified deposits of the district between the Bay of Santandar and the river Deva. It commences with an outline sketch of the physical geography of the province of Santandar, an area some 60 miles by 25, and an outline of the geology. Mountain-chains are its dominant physical feature, the southern boundary resting on the Cantabrian chain. The centre and south-west of the province are occupied, according to the authors, by two groups of rocks ; one, the most massive, and constituting some of the highest peaks of the south-west, is represented chiefly by a limestone remarkably jagged in its outlines, hard and splintery, generally white externally, where exposed, but greyish internally, and often almost black in its lowest part. At its base this limestone seems to be associated with a hard grey sandstone rock, and both rest unconformably on thick beds of slate-clay. Beds of conglomerate, formed chiefly of quartz pebbles, with an extremely hard siliceous cement, are associated with the slate-clay. The limestone rocks appear very much upheaved, and the strata are of the nearly vertical, and forming a succession of anticlinals, the general strike of which may be taken as E. a few degrees W.

The second group of rocks consists of beds of variegated clays alternating with soft sandstone beds of slate-clay, thin beds of marly limestone of a dark grey colour alternating with thin layers of black marly clay. The predominating colour of the sandstones is red. The limestone rocks, upon which the beds of clay, sandstone, etc. rest, rise to the south and south-west in the lofty mountains of the Picos de Europa.

After detailing with full particulars numerous sections, the author attempt to summarize and deduce the stratigraphical succession and relative ages of the different rocks. To do this, they first take such horizons as are naturally sufficiently definite. The nummulitic series offers one which is not only convenient as the newest or uppermost, but is also topographically the first, being near the sea-shore. The nummulitic rocks rest on cretaceous beds, which occupy a narrow band of country near the sea, in the west of the province, and become largely developed towards the east. Those on the north side of the Bay of Santandar have been studied by M. de Verneuil, who considers the beds lying between the Bay and the lighthouse to belong to the Upper Chalk Marls, and the authors sufficiently establish their position as the first horizon below the nummulitic beds. Those beds which form the quay of Santandar strike off towards the west, and are found not only to overlie the dolomite of Peña Castillo and the immense mass of the same rock lying about the south-west of the Bay of Santandar, but may be traced along the coast up to San Pedro, and inland to Reocin and La Florida. This dolomite is in some places 120 mètres thick. The beds which underlie contain *Calamophyllia Stokesii*, *Rhynchonella rimosa*, *Ostrea deltoidea*, *Photodomya lyrata*, *Ammonites bifrons*, *Ammonites serpentinus*. Pectens and belemnites are seven, which are undoubtedly jurassic, while in the dolomite itself ammonites similar to those of the underlying beds. The authors therefore put this dolomite at the top of the jurassic series, and make of them a second well-defined horizon.

About the upper boundary there can be no difficulty, but it is otherwise with the lower limits. Beneath the dolomite are a series of beds of hard shelly argillaceous limestone, with variegated clay-beds passing into reddish-grey sandstone, beneath which are thick beds of red micaceous sandstone ; next follow the beds of compact blue or black limestone, containing metalliferous deposits, and forming the axis of the east and west chain called the Dobra. Beyond Monte Dobra, in the valley of Los Corrales, there is a repetition of the thick beds of red sandstone. In the upper members of this series many jurassic fossils have been found ; but, according to the authors, none at all in the great beds of red sandstone; hence the question, are all these beds jurassic, or does the red sandstone represent an island of the Trias? The authors incline to the opinion that all the rocks between the dolomite and the Dobra are jurassic, including the Dobra limestone itself. If the Dobra limestone be jurassic, the authors contend that the eastern part, if not the whole of the Cantabrian chain, which reach 2600 feet, are likewise jurassic; and that the conclusion then is inevitable, that the jurassic formation extends into the province of the Asturias, and that the whole of the geology of the eastern part of that province requires rectification.

After the geology, the third part of the book is devoted to the geognostical relations of the more important metalliferous deposits, and the fourth to the mineralogical structure and chemical composition of the ores, with some remarks upon their mode of production; and finally, we have chapters on the deposit of sulphate of the soda in the valley of Jarama, near Aranjuez; on the chemical composition of a lacustrine dolomitic limestone in the neighbourhood of Madrid; and on some curious molecular changes produced in disilicate of zinc and some of its compounds with carbonates by the action of heat. This work is well worthy of the attention of geologists.

Geological Essays, and Sketch of the Geology of Manchester and the Neighbourhood. By John Taylor. London: Simpkin, Marshall, and Co. 1864.

It is refreshing to take up a book on Geology in which we find ourselves free from the set phrases and pratings of the old school of geologists, or the hackneyed and tiresome inveighings against the hard words of science, so common in the multitude of works on so-called popular science. Of geological nomenclature, at least, Mr. Taylor takes a more sensible view than most of his "popular" contemporaries, and he at least considers geological classification as the grammar of geology, without which—

> "The student could no more make headway than he could read Horace or Virgil without having first learned to construe in Latin." "Nomenclature," continues Mr. Taylor, "is the 'slough of despond,' through which every man must wade ere he can cultivate the acquaintance of any science whatever. It is the Cerberus which guards the gates of its under-mysteries, the cipher whose knowledge unfolds the gathered wisdom of centuries; after this difficulty has been overcome, no man will stand up more for its utility or find it more serviceable than he who at first sight was about to turn away with mingled feelings of disgust and despair; and although such a classification is anything but perfect, and by no means to be relied upon as infallible, it serves as a clue to the mode of natural operations in bygone epochs. In short, its utility may be seen by the fact that it has been originated by those very men who wandered for years amid the complexities of geology, often without so much as an idea of their labours; and these technological terms are the results of their patient investigations and long years of experience."

We cannot always agree with the author however, who, it is only just to say, follows closely to received opinions, some of which, it is well known, we have long been disposed to contest. One of these points to which he adheres is the old igneous origin of certain crystalline rocks:—

> "We may learn from this," he says, "that the various rocks of *igneous* origin owe their numerous modifications to the circumstances under which they have solidified, not to any difference in their origin; the only changes being what they have lost or what

> they may have gained in passing through previous formed rocks. Had it not been for the outburst of such igneous rocks, our 'old and craggy earth,' as Cowper calls it, would have been full of yawning chasms, and its solid crust would have presented an appearance something similar to a clay-bank that has been exposed to a July sun. But the fluid molten matter has been squirted from beneath into all the fissures which had been formed from the contraction of the masses after their formation, and has bound and cemented them together. Nay, were it not for the existence of such outlets to the *fiery* reservoir below *these volcanic vents*, our world could not have lived out half its days. These have been, in all stages of its history, the *safety-valves* to let off the superfluous potency, instead of being *pent up and exploding the thin shell formed by the stratified rocks*, or causing the earth to come to *an untimely end by its disjointed continents wandering in several orbits* through space, in a manner similar to that hypothetical planet Pluto."

Mr. Taylor has said here nothing new which others have not said before, but the passages we have set in italics will show the incongruity of the items of which this igneous theory is compounded; for how that which has *cemented* together the fractures of the shell of our earth can be a means of *outlet* for the *liquid* matter beneath, is not clearer than is the source of the heat that made and maintains a molten core attributed to our planet. As to the origin of these so-called igneous rocks, just let us put againt these old parrot-repeated dicta what Sterry-Hunt, one of the best of modern geologists, has recently written in his "Contributions to Lithology," in Silliman's Journal.

> "I have already, in other places, expressed the opinion that the various eruptive rocks have had no other origin than the softening and displacement of sedimentary deposits; and have thus their sources *within the lower portions of the earth's stratified covering, and not beneath it.* The theory which conceives them to have been derived from a portion of the interior of the earth still retaining its supposed primitive condition of igneous fluidity, is, in my opinion, untenable. It is not here the place to discuss the more or less ingenious speculations of Phillips, Durocher, and Bunsen as to the constitution of this supposed fluid centre, nor the more elaborate hypothesis of Sartorius von Walterhausen as to the composition and arrangement of the matters in this imaginary reservoir of Plutonic rocks. *The immense variety presented in the composition of eruptive masses, presents a strong argument against the notion that they are derived,* as these writers have supposed, *from two or more zones of molten matter, differing in composition and density, and lying everywhere beneath the solid crust of the earth*, which, in opposition to the views of many modern mathematicians and physicists, the school of geologists just referred to regard as a shell of very limited thickness. The view which I adopt is one, the merit of which belongs, I believe, to Christian Keferstein, who, in his 'Naturgeschichte des Erdkörpers,' published in 1834, maintained that *all the unstratified rocks from granite to lava are products of the transformation of sedimentary strata, in part very recent; and that there is no well-defined line to be drawn between Neptunian and Volcanic rocks, since they pass into each other.*"

The general tenor of Mr. Taylor's Essays however is very good, and his book is a very readable and useful one, especially in all that he has to say on the local geology of those districts in which he has resided. Thus the accounts of the Lancashire coal-field and of the strata in the vicinity of Manchester, are exceedingly interesting, while the illustrations of fossil plants and shells are very appropriately selected.

Flora of Surrey. By J. A. Brewer. London: Van Voorst. 1863.

This is a full and comprehensive catalogue of the flowering plants and ferns found in the county, with the localities of the rarer species, from the manuscripts of the late J. D. Salmon, F.L.S., and from other sources, compiled for the Holmesdale Natural History Club, at Reigate, by Mr. Brewer. The work is in small octavo, and contains nearly 370 pages, and two large excellent folded maps—one of the geology, the other botanical provinces; and it will be useful to add, that the geological map can be purchased separately in sheet, case, or on rollers. In accordance with Mr. Salmon's plan, the county has been divided into nine districts or divisions, for the purpose of more readily ascertaining the particular localities of the plants. The geological map has been prepared and coloured from one drawn by Mr. Prestwich, and we need not say will consequently be acceptable to all who are interested in the geology of the county. The three principal groups of geological strata are the Wealden, the Cretaceous, and the London Clay; Reading and Woolwich beds, Thanet sands, and other Tertiary beds surmounting the Chalk. Here and there, especially along the river-valleys, are accumulations of gravel and drift deposits. The whole of the north-eastern division of the county belongs to the London Clay formation, and is comparatively low; and consequently the various elevations on the north side, such as Denmark, Herne, and Richmond hills, although of no great elevation, still command extensive prospects. It also forms the hills running southward along the Kentish border by New Cross, Forest Hill, Sydenham, and Norwood. It is estimated that in some situations the London Clay is nearly a thousand feet thick, but that that portion which extends into Surrey does not exceed 500 or 600 feet. The principal feature of the northern district is again the London Clay, covered in places by the Bagshot sand, as in the vicinity of Esher. The whole of the north-western division consists of London Clay, for the most part covered with the Bagshot sand, and presenting a poor, hungry, unimprovable soil, as at Bagshot heath itself, which lies within this region. Large masses of the siliceous sandstone known as "grey wethers" are found there. The entire eastern division is occupied by the Cretaceous rocks, with the exception of a small portion of the Reading and Woolwich beds, and the Thanet sands, which occur to the east of Croydon. The Chalk occupies a considerable area, and forms a portion of the North Downs. The Upper Greensand, or freestone, forms the foot of the escarpment of the Downs, and extends from Godstone by Merstham and Reigate through the county into Hampshire. The central division is principally occupied by the Chalk, but its north-west angle shows London Clay, which at Ockham Heath and Send is covered with Bagshot sand; and a narrow slip of the Woolwich and Reading beds runs along the northern margin of the Chalk. The western division is principally occupied by London Clay, but a narrow ridge of chalk, known as the "Hog's back," runs almost the whole length of the southern boundary, and at the foot of which the Gault and Upper Greensand crop out. The south-eastern division is, with the exception of a narrow strip of Lower Greensand on the north, occupied by the Weald Clay—the Hastings sand appearing at the south-eastern corner. The southern division is equally divided between the Greensand and Weald Clay. The principal stratum in the south-western division is the Lower Greensand.

The following is a brief analysis of the distribution of the plants:—The total number of species occurring is 117; the number confined to the valley alluvium, 7; to the superficial gravels, 19; to the Bagshot sands, 9; to the London Clay, 14; to the Reading and Woolwich beds, 2; to the Chalk, 55; to the Upper Greensand and Gault, 5; and to the Lower Greensand, 28.

Descriptive Catalogue of the Salisbury and South Wilts Museum. Salisbury: Bennett. 1864.

Proceedings of the Inauguration of the Salisbury and South Wilts Museum. Salisbury: Bennett. 1864.

The establishment of a new museum is always a matter of note, but that of an important one in so remarkable a district, both archæologically and geologically, as Wiltshire, is unusually interesting. The inauguration took place in January of the present year, an account of which was duly sent to us, but want of space prevented our noticing it at the time. We also received an illustrated descriptive catalogue of 112 pages and 14 plates, which is a very model of what should be done for every local museum. The stone, bronze, and early iron objects have been catalogued by Mr. E. T. Stevens; the mediæval series and the pottery, by Mr. Nightingale; the mediæval seals, by Mr. W. Ormond; the mammalian remains of the Pleistocene period, by our talented contributor Dr. H. P. Blackmore, and the birds by Mr. Henry Blackmore. It should be distinctly understood that this is not a mere bare enumeration of the objects deposited in the museum, but that popular and intelligible explanations of the uses, objects, purposes, and nature of the objects registered, are freely and fully appended. Too much praise cannot be given to those who have thus striven to make the Salisbury Museum instructive to visitors of all denominations and degrees of education and intelligence.

Geological Survey of Canada.

The Report of Progress of this most important survey, from its commencement to 1863, illustrated with nearly five hundred woodcuts, has been produced by the officers, Sir William Logan, Director, Mr. Alexander Murray, Assistant Geologist, Mr. T. Sterry Hunt, Chemist and Mineralogist, and Mr. Billings, Palæontologist. A noble volume it is, of all but a thousand pages, worthy of the clever, active, and indefatigable Director, of his able staff, and creditable in production to the printer and the engraver; for Montreal, in this respect, could not be expected to rival our own metropolis, but the typography and press-work are remarkably good for colonial work. An atlas of maps is to accompany the volume, but is not yet complete. The Geological Survey of Canada was instituted by the Provincial Government in 1843, and since then results have from time to time been submitted to the Legislature and published. The present volume contains, in a perfect form, the substance of those periodical reports, with a great deal of original matter; and the work, as now presented, is a grand record of the full labours of the Survey.

Flora Belfastiensis. By Ralph Tate, F.G.S.

As Belfast was without a complete local Flora, the little book before us will supply a decided want, and emanating from a gentleman who is an excellent geologist as well as a botanist, those special points which give the peculiar value which local Floras have to the field-geologist, will naturally have received due and more than usual attention. The list of plants seems to us a very full and perfect one; but it is the introductory description of the physical features of the district that geologists will find most instructive. It is well known that relations exist between the various soils and the plants which grow upon them; but as drift and other superficial deposits are commonly widely spread over many areas, it follows that the classes of plants growing over the surface do not necessarily, and very commonly do not, represent the varieties of the rocks constituting the main geological structure of the county. Wherever a diversity of rock occurs, we have a corresponding diversity of species, and these again are increased or diminished in numbers in accordance with the amount of disintegration suffered, the capacity to imbibe water, and other conditions of the rocks. The district under consideration is divided by the Belfast Lough and the river Lagan into two well-marked sections, both as to the geological strata and as to geographical relations. The northern section is occupied by the Belfast Hill Range, the basis of which is the Keuper formation rising in a steep incline. The New Red is surmounted by the Lias, the Upper Cretaceous rocks and Basalt forming a bold escarpment extending from Whitehead to Lisburn, with an average elevation of a thousand feet, from the heights of which the land slopes gently inland, forming plateaus of great extent. The southern section, excepting some patches of the newest Tertiaries in the neighbourhood of Bangor and in the Knock Valley, is composed of Palæozoic rocks. Surmounting the Silurians are the freestones of the Old Red Sandstone, in some places capped by Greenstone Porphyry, a mere strip of Carboniferous Limestone occurring at Castle-Espie. Beds of the Permian age occupy the coast-line at Caltra. The districts of Lagan, Knock, Ballyaholly present extensive marshes, and peat-bogs are encountered at high elevations in the northern section, as on the Black Mountains. With a region so varied in its geological surface, and so diversified in its physical aspects, we might expect to find a great variety and diversity of plants; and so it is: Mr. Tate records 602 species.

Professor Phillips's 'Guide to Geology.'

There is no book we know of more worthy to be put in the hands of beginners in geology than the pretty work of Professor Phillips, the fifth edition of which is now before us, nor is there any more fitted for giving a rudimentary knowledge to the general public, especially such as wish to get sufficient knowledge to understand the main discussions of such importance as are now being carried on. Professor Phillips's long experience as a teacher has well fitted him for giving such instruction. He is an acute thinker, a voluble speaker, and possesses a love of his science and great earnestness. There is a tendency in his thinking towards speculativeness which makes his writings more suitable to the understanding of ordinarily educated persons, and peculiarly pleasant to those who wish to understand the controversies of the day. At the same time the main philosophical principles of geology are not neglected, and the object of the science, the earth's condition as a planet considered, and the nature and character of the primitive land discussed; the elementary substances which enter into the composition of rocks, their stratigraphical arrangement given, the origin of rocks stratified and unstratified, the physical geography and general structure of the earth pointed out. The subaqueous production of land, its elevation, the relative antiquity of its various portions, the changes of climate, the series of life and vegetation which have existed in past time, the various proposed methods of estimating the lapses of geological time, are other subjects equally well and clearly treated, the last two chapters being devoted to lithology, and to tables and calculations.

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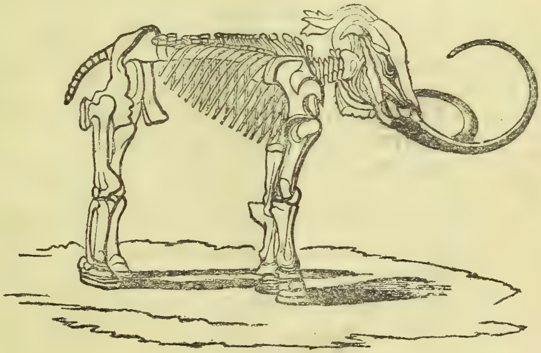

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The Philosophy of Geology : a brief review of the aim, scope, and character of geological inquiry. By David Page, F.R.S.E., F.G.S. Edinburgh and London : Blackwood. 1863.

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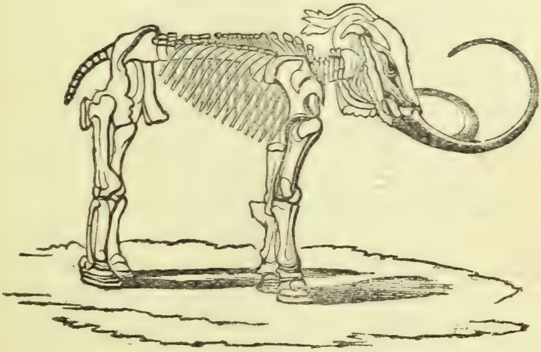

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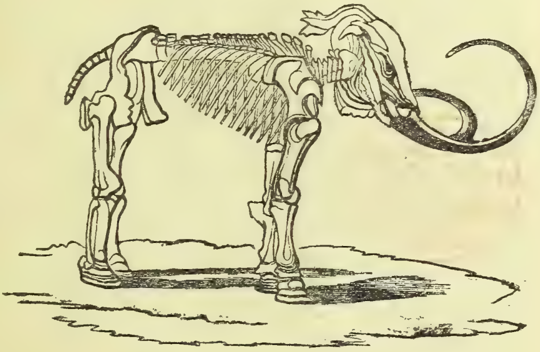

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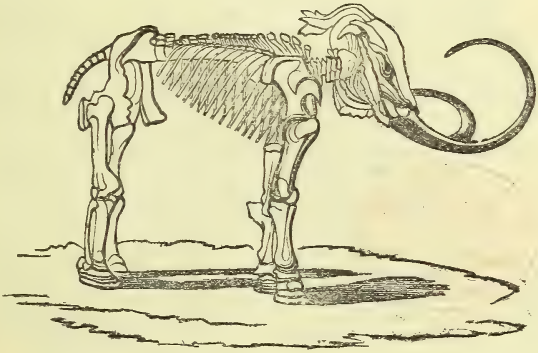

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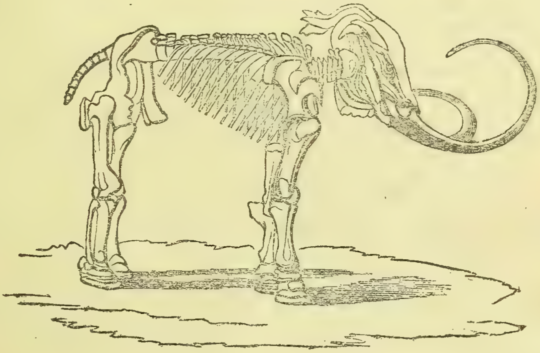

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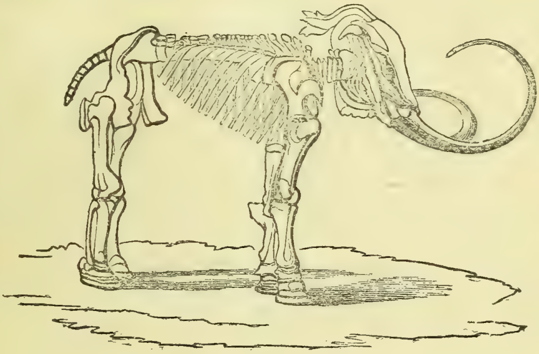

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